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An Integrated Marine Environmental Compliance Program for Naval Shipyards: Final Phase I Report (December 1995)

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This document was first prepared as a limited distribution report by the Naval Command Control and Ocean Surveillance Center Research, Development, Test and Evaluation Division (NRaD). That corporate title appears throughout the document. In September 1997, NRaD became Space and Naval Warfare Systems Center, San Diego (SSC San Diego). This document is now a formal technical report of SSC San Diego, but for cost prevention and historical documentation purposes, the command title at the time of original publication is retained.

EXECUTIVE SUMMARY

Naval shipyards face a dilemma in protecting the marine environment. The number of regulations, the number of parameters subject to monitoring or limitations, the analytical precision required to measure the parameters, and the stringency of limitations have increased dramatically over the past decade. The cost of complying with environmental regulations has increased rapidly, with no clear evidence of commensurate increases in protecting the marine environment.

The current regulatory structure compounds this dilemma. Laws and regulations have been fashioned for specific media (e.g., water, soil, air, toxic waste) or specific conditions (e.g., point sources, stormwater, dredging) rather than on an integrated strategy for protecting marine resources. Consequently, shipyard environmental programs have sometimes differing and contradictory protection goals and needless barriers to cooperative environmental sampling and information sharing. Conflicting signals from regulators regarding the future direction of marine environmental compliance add to this problem. Part of the regulatory community continues to pursue a goal of zero industrial discharge and the continued ratcheting down of effluent limits to reach that goal. Other scientists and policy-makers at the Environmental Protection Agency (EPA) and the States are recommending a shift towards integrated approaches that apply risk-based management techniques to ecosystems and watersheds.

In 1987, amendments to the re-authorization of the Clean Water Act (CWA) brought these issues into sharper focus for the shipyards. These amendments gave stronger mandates to States to develop water quality standards for 126 toxic compounds. New permits issued under the CWA's National Pollutant Discharge Elimination System contained much more stringent limits for many toxins such as metals, limits that were often in the part per billion or lower range. It also produced the recognition that negotiating these limits with the regulators would require a broader range of expertise in the marine sciences than is generally available at the shipyards.

The Naval Sea Systems Command (NAVSEA) contacted the Marine Environmental Support Office (MESO) in February 1994 to develop a long-range, cost-effective strategy for marine environmental compliance. NAVSEA wanted to position the shipyards at the forefront of scientific knowledge of monitoring and database system integration under a risk-based framework. The Naval Command, Control and Ocean Surveillance Center RDT&E Division (NRAD), where MESO is located, has broad experience in the marine sciences and the application of ecological risk assessment techniques to marine environments.

In response to the NAVSEA tasking, MESO developed a phased plan to be accomplished over a 4-year period. This report covers Phase I of that plan. It reports the results of the on-site investigations MESO conducted to establish the status of the marine environmental compliance programs of the shipyards. The second and third phases proposed by MESO will evaluate environmental monitorring strategies and develop a database management plan to assess and document the long-term health of marine ecosystems at the shipyards. These two phases will also initiate the involvement of the regulatory agencies responsible for overseeing the compliance programs of the shipyards. The final phase will provide a long-term monitoring plan specific to each shipyard and general guidance for shipyards to use the monitoring data in ecological risk assessment studies to support environmental compliance decision-making. Throughout all of the proposed phases, MESO will provide scientific support to the shipyards by assisting them with permit renewals, sampling and analysis plans, and data management issues. The environmental compliance program developed by MESO, specifically developed for naval shipyards, can be adapted to any shoreside facility.

This report focuses on visits by the MESO staff to the five naval shipyards not slated for closure when the project began (Long Beach, Portsmouth, Puget Sound, Norfolk, and Pearl Harbor). The analysis contained in the report is based on questionnaires sent to the shipyards, in-person and telephone interviews with shipyard personnel, research of related environmental documents, information already on file at MESO, and site visits to the shipyards to view the processes, discharges, and other activities affecting the receiving waters.

This report begins with the Summary Recommendations and Conclusions, which synthesize the recommendations MESO developed during Phase I. The Summary Recommendations are located at the beginning of the report to introduce and emphasize the importance of the recommendations before presenting supporting documentation. Many summary recommendations also span the boundaries among the environmental programs of the shipyards. Sections 1 through 3 introduce the background and objectives of the study, describe the methods used to gather and analyze the data, and outline the environmental setting at the five naval shipyards. Sections 4 through 8 describe the NPDES, Stormwater, Installation Restoration, Dredging, and other regulatory programs, respectively, at the shipyards. Finally, sections 9 and 10 provide a closer look at two critical support functions: (1) environmental data management, and (2) testing laboratories. These chapters present the near- and long-term recommendations specific to each regulatory program.

As noted above, the Summary Recommendations provide a synopsis of the recommendations of this study. In general, MESO found that the shipyards are complying with existing regulatory requirements. They have made significant progress using best management practices to reduce the sources of pollution through workplace cleanliness and process controls, especially in their dry-docks. Despite these efforts, several shipyards are experiencing problems complying with permits that impose stringent effluent limitations adopted directly from national water quality criteria with no allowance for site-specific characteristics. Many shipyards are finding the only way they can achieve consistent compliance is to modify their dry-docks to segregate, collect, and process the wastewater.

MESO found there is a general lack of planning at the shipyards for changes that will almost certainly result from current regulatory trends. There is little effort to share data and insights across programs or to work toward the integrated, risk-based approach proposed by EPA. These findings were expected, and they reinforce the NAVSEA decision to bring MESO and the shipyards into a partnership to plan an integrated long-term marine compliance program.

Finally, the shipyards may be able to implement some of the recommendations made in this Phase I report immediately. However, other recommendations will require negotiation between the shipyards and their regulators. They may also require additional time and resources to implement. MESO is ready to assist the shipyards to attain these goals.

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INTRODUCTION

This summary provides a synthesis of the environmental programs of the shipyards. Sections 1 through 10 discuss many of these same issues, but the emphasis in this summary is on recommendations that span the boundaries among environmental programs of the shipyards. Many of these inter-program recommendations are provided only in this summary. Conversely, many of the program-specific recommendations are provided only in sections 4 through 10. The recommendations outlined generally fall outside the shipyards' current regulatory structure. They recommend actions that will integrate the shipyards' various regulatory programs and shift them towards a risk-based approach. Some recommendations can be initiated now. Others will require more time or resources to implement. MESO will work with the shipyards during the coming months to determine how to implement the details of the recommendations in this report.

CURRENT STATUS OF REGULATORY PROGRAMS

Naval shipyards face a complex mixture of environmental laws and regulations that often have unclear relationships to the resources they intend to protect. Many environmental processes extend beyond the geopolitical boundaries of the shipyards and the various regulators to which they must respond. Understanding these processes requires a spatial perspective that includes the entire water body in which the shipyard is located, the surrounding watershed, and adjacent offshore regions. Moreover, society's view of environmental status may be limited to human health or the well-being of commercially important species, but the shipyards must understand the physical–chemical processes governing the fate and effects of materials released into the environment. Such understanding requires data from many disciplines collected over a long time and a broad geographic region.

Two areas of particular concern are the increasing number of environmental regulations and the rising cost for the shipyards to stay compliant. The number of environmental regulations under which the shipyards must operate has increased tenfold in the past 30 years (figure 1). The effects of this increase can be seen in the cost of compliance, confusion over contradictory regulations, and in some cases, excessive capital or operating costs with no clear benefit to the environment.

The cost of environmental compliance is evident at many levels. Nationally, the Environmental Protection Agency (EPA) estimated in 1990 that the annual cost of all pollution control activities was $115 billion per year (USEPA, 1990b). EPA also estimated this figure could reach as high as $185 billion per year by the year 2000. In terms of just the monitoring component of these expenses, EPA estimated that its regulated community spent $5 billion in 1994 on environmental data collection (USEPA, 1994f). Of that total, Sample (1994) estimates that the U.S. Navy spent $130M in 1994 on environmental testing. For the shipyards, the Long Beach Naval Shipyard (LBNSY), estimated it would cost $148 million for LBNSY to remain in environmental compliance for a decade (Naval Environmental Support Activity, 1991).

Coupled with the increased number and interaction of environmental regulations is the continued "ratcheting-down" of compliance limits. For metals, the increased emphasis on water quality criteria following the re-authorization of the Clean Water Act (CWA) in 1987 has produced limits that are nearly 300 times lower than those required under technology-based controls (USEPA, 1994a). At the LBNSY, many limits specified in the discharge permit are below the detection limits of the prescribed analytical methods. In addition to making it more difficult to achieve compliance, a tenfold increase in analytical precision can easily double or triple the cost of the analyses.

The number of measurement parameters is increasing along with the analytical precision required to make these measurements. The NPDES permit for PNSY may represent the end of traditional monitoring requirements with only five parameters. The new NPDES permit at NNSY includes 30 parameters measured with 12 different monitoring schemes prescribed for the 16 point source outfalls. The previous permit at Norfolk listed 20 parameters under 8 schemes for 12 outfalls. The Norfolk Naval Sxhipyard alone is responsible for 131 of the 200 periodic measurements assigned to all naval shipyards. A similar increase in the number of parameters and measurement precision is likely when the NPDES permits are renewed at the other shipyards, and in the newly implemented Stormwater programs.

The compartmentalization of programs by the regulated community to parallel environmental laws and regulations also contributes to the cost and complexity of environmental regulations. The NPDES and Stormwater programs, for example, differ primarily in the source of the discharge (i.e., point versus non-point sources, respectively). Similarly, the three regulatory programs the U.S. Navy has incorporated under Installation Restoration are narrowly defined. The Comprehensive Environmental Response Compensation and Liability Act (CERCLA) deals only with hazardous sites contaminated before 1980. The Resource Conservation and Recovery Act (RCRA) Corrective Actions address only sites contaminated after 1980. The Underground Storage Tanks (UST) program focuses only on contamination from leaking underground storage tanks. Ecological Risk Assessment, which, in theory, is broad in scope, has been applied only to meet the requirements of CERCLA (and in the case of the Portsmouth shipyard, RCRA Corrective Actions). Finally, Oil and Hazardous Substance Spill Response programs prepare for certain types of events (catastrophic spills) while the Natural Resources Management Plans are intended to protect and manage all of a facility's natural resources.

While the implementation and enforcement of environmental regulations have been piecemeal, the original statutes upon which they are based have a broad scope. This situation, coupled with the fact that different regulatory programs often address pollution within the same medium (air, ground, water, or sediments), has lead to the curious situation of narrowly focused programs with a broad charter. For example, the original intent of NPDES was to eliminate both point and non-point pollution sources. Only within the last 2 years have programs been developed to address non-point sources. To complicate the issue, two separate programs are being implemented: Stormwater monitoring incorporated into the NPDES regulations, and the Coastal Non-Point Pollution Control Program, evolved from the Coastal Zone Act Reauthorization Amendments to the Coastal Zone Management Act. Gradually, NPDES permits are being renewed to include stormwater, as is the case with the Puget Sound and Norfolk Naval Shipyards. Similarly, dredging operations and Installation Restoration (IR) programs at the shipyards routinely perform the same types of environmental testing on sediments, but for different purposes. The Natural Resources, Oil and Hazardous Substances, Spill Response, and Ecological Risk Assessment programs are all involved in the assessment of ecological resources, but for different purposes.

While these programs should have broad perspectives that look at many of the same processes, for the most part, they are not sharing their measurement data because the regulations that they are responding to are fragmented. For example, the IR programs address pollution practices before 1980 and, therefore, often overlook present-day pollutant inputs (e.g., NPDES or stormwater) that might affect their remedial investigations. Likewise, sediment data collected for past dredging projects or under IR investigations could be used to examine the effects of ongoing effluent discharges. In most cases, they are ignored in the administration of NPDES permits.

Compartmentalization along programmatic lines is not the only factor erecting barriers to sharing environmental information. In some cases, a lack of information about the source of contaminants

makes it unclear which program is responsible for monitoring and correcting the situation. For example, the criteria for deciding whether an outfall should be classified as carrying stormwater, wastewater, or sewer water are relatively straightforward. What is not clear in many instances is which outfalls are discharging what type of effluent. The age and cross-connection of the shipyards' drain systems have made it difficult to determine the origin and composition of the materials entering a specific pipe. Classifying an outfall under the Stormwater program as a non-point source or under the NPDES program as a point source makes a vast difference. Stormwater regulations currently do not include effluent limits, only monitoring requirements. In addition, NPDES permits require more frequent measurement of more parameters, both of which drive up the cost of compliance.

Perhaps the most troubling aspect of these increases in the volume, complexity, precision, and cost of environmental monitoring is the lack of scientific evidence that they are providing increased protection for the environment. For example, the discharge limit for copper from the NNSY's Industrial Wastewater Treatment Plant outfall, which is situated in the midst of dry-docks, is 10 times higher than the limit for the dry-dock outfalls covered by the same NPDES permit. These very different limits cannot be equally protective of the same affected ecosystem. Unfortunately, as is evident in section 3, there is insufficient information on adjacent marine biological resources available to the shipyards to evaluate the ecological significance of these regulatory decisions. The shipyards have very little baseline data from which to monitor changes in the ecosystem, either from natural variability or from human influence such as pollution. In most cases, knowledge of the relative contribution of non-Navy sources to the pollution of the coastal and estuarine waters adjacent to a shipyard is also lacking.

RECOMMENDATIONS UNDER CURRENT REGULATORY SCHEME

Recommendations for changes the shipyards can undertake within their current regulatory scheme fall into two broad categories: (1) changes that will combine, coordinate, and redirect the shipyards' monitoring, sampling, and analysis programs, and (2) changes to support services such as information management and environmental testing. These two categories are inseparable and should be implemented together. Combining two sampling programs makes no sense if the environmental laboratory cannot perform both sets of analyses and if the two programs have no mechanism to share the results. However, the two categories of recommendations are separated below to make the long list of recommendations more readable.

Monitoring, Sampling, and Analysis

The shipyards' should begin to coordinate the sampling and analysis requirements of their environmental programs. They should also begin to share measurement data they have already collected between programs and among shipyards. NRaD will assist the shipyards to analyze their data sources and establish a baseline environmental assessment. This analysis will identify gaps in the parameters measured and media analyzed (water/sediment/tissue) over space and time. The ultimate goal should be to determine the potential human and ecological health risks from documented contaminant levels.

Evaluate Program Monitoring Requirements. The shipyards should work with their regulators to ensure that the monitoring requirements of their NPDES and Stormwater permits are appropriate and relevant to the primary goal of the Clean Water Act: "achieve a level of water quality which provides for the protection and propagation of fish, shellfish, and wildlife." Permit requirements such as measurement parameters, discharge concentration limits, and monitoring design (location, frequencies, etc.) should assess the health of the affected aquatic ecosystem.

Use Available Data to Gain a Comprehensive View of the Marine Environment. As mentioned earlier, environmental agencies are beginning to develop regional programs so that water quality regulation will be based on the broader perspective of specific watersheds. During the following phases of this project, NRaD will work with the shipyards to gather non-Navy scientific information about the aquatic environments in which the shipyards operate. An assessment of available data should be made before NRaD can recommend larger scale water body studies or develop specific long-term monitoring plans. One objective of this research would be to gain an understanding of all sources of pollutants into the water body and their relative contributions to the total input. This is important because the shipyards operate in areas where many other sources exist: sewage treatment plants, industrial discharges, urban and agricultural runoff, atmospheric deposition, and residual contamination from historical discharges.

Collect Additional Data to Develop Site-Specific Criteria. The shipyards should work with their respective regulators to move from the direct application of national criteria and standards towards modification of some to develop site-specific criteria. If a regional watershed approach involves a consortium of interested parties (including permitted dischargers), the shipyards can participate in hydrodynamic mixing and contaminant transport studies so that more accurate Total Maximum Daily Loads, Wasteload and Load Allocations, and Mixing Zones can be calculated. In the absence of such a coordinated interagency effort, the shipyards can establish more realistic discharge limits by completing smaller scale site-specific studies such as Water Effects Ratios, Recalculation Procedures, and Chemical Translators.

Implement Cost-Effective Monitoring Strategies. Broader application of strategies such as tiered sampling can make more cost-effective use of the shipyard's monitoring resources. The EPA and Army Corps of Engineers (ACoE) require tiered testing for dredging projects that may be modified for use in NPDES, stormwater, IR, and other monitoring efforts or studies. In a tiered approach, a screening test such as a bioassay is used to first evaluate the toxicity of the medium. The screening test results are then used to decide what and how to sample in later analysis of that medium (e.g., sediment chemistry). If necessary, tests that are more specific can be used to further refine the assessment. The advantages of the tiered approach are speed and cost. Using a rapid toxicity test such as QwikLite (Lapota, Moskowitz, Rosenberger, and Grovhoug, 1994), the shipyards can make a quick determination of potential "hot spots." They can then use these results to be more selective in their use of expensive analytical chemistry measurements to identify and quantify specific contaminants.

Apply Representative Discharge Monitoring. As discussed for stormwater (section 5), representative discharge monitoring (RDM) allows the shipyard to monitor one outfall and report the results for other outfalls with essentially identical effluent compositions. A review of the shipyard's NPDES monitoring data should establish whether RDM is feasible for those outfalls too. If it is, the shipyards should petition their regulators to allow RDM for NPDES outfalls. It may also be possible to apply RDM to representative discharges on a temporal basis. This would entail monitoring the effluent from NPDES outfalls once every other month instead of every month. The cost savings realized from implementing spatial and temporal RDM could be substantial and could then be applied to pay for biological or ecological testing under replacement monitoring.

Propose Replacement Monitoring. The shipyards should propose replacing strictly chemistry-based effluent monitoring with more relevant ecosystem monitoring. Years of effluent monitoring have produced a wealth of information about shipyard inputs into the water bodies, but the CWA goal of protecting human and environmental health from water pollution cannot be assessed by measuring effluent concentrations. Shipyards should work with the regulators to replace some of the effluent monitoring requirements with analyses of receiving water and sediments. Likewise, the

shipyards should propose using more relevant measures of ecological effects including alternative bioassays, bioaccumulation, biomarkers (or bioindicators), and benthic community analyses. The shipyards should also consider negotiating to replace extensive stormwater chemical monitoring with some of these other methods to bring more ecological relevance to that program.

Use Shipyard Environmental Laboratories. The shipyards should expand the use of their in-house analytical laboratories for environmental measurements. They should also use these laboratories as the clearinghouse for analytical measurements made by contract laboratories. Before the shipyard laboratories can fulfill this role, they must:

- Be adequately staffed to handle the workload in a timely manner;
- Be certified by national accreditation organizations to perform trace-level analyses on seawater, freshwater, sediment, and tissue media;
- Be capable of collecting samples and performing analyses under clean and ultra-clean conditions;
- Support the analytical requirements of all the shipyard's environmental programs, including some biological testing;
- Ensure that the contract laboratories the shipyards use are equally capable and certified;
- Record all of their measurement, QA/QC, detection limit, procedural, and related information in an accessible computer database (see SLIMS above).

Information Transfer and Data Management

Improve Communications Among Shipyards. All shipyards face similar regulatory requirements, and their staffs can benefit from the approaches other shipyards have taken in meeting these requirements. However, the 6-hour time difference between Hawaii and the East Coast makes it difficult for the environmental staffs to communicate. A simple and cost-effective solution to these problems is for the shipyards to enable the environmental staffs to exchange information electronically. Specifically, the shipyards should provide a desktop Personal Computer (PC) with electronic mail (e-mail) capability to their environmental staffs. Using e-mail, a staff member at one shipyard could: (1) ask a question and have it sent simultaneously to any or all of the other environmental managers, (2) ask questions when it is convenient, and (3) respond to questions posed by others when it is convenient. E-mail also provides a written record the staff can use to document responses, review them later, and incorporate them into other documents. Modern e-mail programs can attach other documents to the mail message, including spreadsheets, word processing files, graphics, and sound files. They can also encrypt these attachments so their contents are protected.

All shipyards have the basic communications infrastructure to support e-mail. However, not all members of the environmental staff have a PC workstation on their desk with the appropriate operating environment, e-mail program, and connection to the shipyard's local area network (LAN). Depending on their degree of computer literacy, some environmental staffers might also require training to use the e-mail program. However, a co-worker or someone else can generally provide this training at the shipyard.

Communicate with Colleagues Outside the Shipyards. The shipyards support Internet access and the environmental staff can therefore use e-mail to communicate with anyone with access to the Internet. This vastly expands the community of environmental scientists to which the shipyard staffs can address a question or comment. There are, for example, numerous environmental discussion groups on the Internet. These are typically organized so a user posts a question or comment to an e-mail address and the message is forwarded to the e-mail address of everyone who subscribes to that discussion group.

Provide Access to the Latest Environmental Information Resources. The environmental staffs of the shipyards need access to the latest environmental information. Some information falls under the category of "news"—policy pronouncements, the outcome of important court cases, publication of a pertinent document, and so forth. Other information includes existing documents: regulations and statutes, technical reports, and bibliographies. Some information sources may even include quantitative measurement data.

This type of information is available today on the Internet through the World Wide Web (WWW). There are literally hundreds of "discussion groups" related to environmental issues. Many of the major environmental agencies with which the shipyards deal now have a WWW site. They are disseminating more and more of their important documents and announcements in electronic form through this medium. Some are even connecting their computer databases to their WWW servers and permitting remote users to query and retrieve data from their database(s). Editorial services (e.g., BNA) which edit and summarize environmental information will probably make these services available over the Internet when a mechanism for paying for the service is available.

Again, the shipyards have the communications infrastructure to provide WWW access to their staffs. At some shipyards, network administrators have established a "firewall" around the shipyard's computers to prevent unauthorized access. The administrator must provide the environmental staff access around the firewall if they are to effectively use the Internet.

Obtain Management Support for Using the Internet. Effective use of e-mail, the WWW, and other resources available on the Internet will require the "buy-in" of management. Managers often assume an employee is "wasting time" if he/she spends time sending and reading e-mail, "surfing" the WWW, etc. In reality, this may the most time- and cost-effective method to obtain the information they need to perform their job. Management must adapt to the changing world of information access by judging the quality of the employee's work, not whether his or her e-mail program is on the computer screen.

Require a Environmental Data Reporting Specification. The shipyards should require all environmental measurement data, whether generated in-house by staff personnel, by the shipyard's environmental laboratory, or externally by a contractor, to be reported in fully documented electronic form. NRaD is in the process of preparing a data reporting specification for this purpose. This specification will exceed the stringent requirements of the CLP (Contract Laboratory Specification) and other programs. Currently, the CLP program does not require data to be reported electronically.

Encourage Electronic Record Keeping. The shipyards should review the record-keeping activities of their current environmental programs and, wherever possible, ensure these records are kept in electronic form. All reports that the Environmental Divisions prepare and receive should be available in electronic form. All plans and procedure manuals for environmental programs (e.g., Stormwater Pollution Prevention Plan, Best Management Practices) should be in electronic form. All event logs (e.g., spill logs, Industrial Waste Treatment Plant [IWTP] discharge logs) should be kept in, or trans-

ferred to, electronic form. NRaD can assist the shipyards to organize these electronic records in a central library that has adequate backup capabilities.

Promote Data Sharing. Data generated by one of the shipyards' environmental programs should not only be reported and stored in fully documented electronic form (see above), but should also be made available in electronic form to the other environmental programs. For example, managers of the IR programs need to use the data from the NPDES, Stormwater, and Dredging programs when investigating contaminated sites and evaluating cleanup alternatives. Initially, "made available" can be as simple as storing the associated metadata files in a common location. This action would allow other programs to determine if the type of data they are seeking is available and who to contact to obtain a copy of the diskette. Eventually, the data should be accessible online in a computer database (see below).

Tie-In to SLIMS. The environmental managers and the staff of the SLIMS Project should open a dialogue regarding their common information-sharing requirements. The next generation of SLIMS will open the possibility for sharing data between the activities collecting the samples in the field and the laboratory performing the analyses. These two groups must agree upon a set of attributes (e.g., Sample ID, Batch ID) that they will keep in common to cross-reference field and laboratory data. The SLIMS design should also include the capability to import data from and export data to other sources, and to link SLIMS into a distributed database of shipyard environmental data. The Environmental Laboratory Advisory Council (ELAC) formed by Chief of Naval Operations (CNO) Code N-45 is the proper forum to establish a dialogue on these topics.

Investigate GIS. NAVFAC is purchasing and distributing an Intergraph Geographic Information System (GIS) to all their field activities. The shipyards should determine if they will have access an Intergraph system at their site.

Seek Out Non-Navy Sources of Environmental Data. Non-Navy sources of environmental data represent another opportunity for the shipyards to expand the breadth of their monitoring programs. These sources may be particularly important in areas where there are significant gaps in the shipyard's own data (e.g., marine data; see section 3). The electronic card catalog of most college and university libraries in the United States is accessible through the Internet. These institutions frequently maintain regional reference collections with a wealth of historical, geographic, and environmental information. The catalogs are often accessible from WWW pages that are linked to other environmental information services in the region. Regional data centers with online databases are also being established across the country. In the Seattle area, for example, the Washington State Department of Ecology maintains a database of sediment measurements from throughout Puget Sound. The integration of sampling efforts and the sharing of analysis results between programs inside and outside the U.S. Navy can amortize the cost of the monitoring programs. It could also provide a much broader spatial and temporal perspective than a shipyard could otherwise afford. Coordination of effort also helps to keep the various program managers informed as to the findings of these other studies.

Establish an Information Server. The five shipyards face many of the same environmental requirements and could benefit from widespread dissemination of the approaches the other shipyards have used. The shipyards should establish an online environmental information server to achieve that goal. Each shipyard should use this server as the repository for all their environmental documents, including the following:

- Planning and Procedures Documents (e.g., Stormwater Pollution Prevention Plan [SWPPP], Best Management Practices [BMPs], Oil and Hazardous Substances [OHS])

Technical Reports (e.g., environmental assessments, regional water quality reports)

- Permits
- Event records
- Workshop handouts
- Pertinent office correspondence (e.g., letters, e-mail, memoranda)

This server should be established as a WWW server. This will allow the shipyards to provide selective access to this information for other U.S. Navy and non-Navy users. This mechanism will also permit the shipyards to create links from their server to pertinent information on WWW servers at other sites, such as Federal, State, and local regulators. However, creating such a server will require modifications to the firewalls that are currently established around the shipyards' computer systems.

Adopt a Common Data Model. The shipyards will need a data model that can represent all types of data and relationships between data used by the environmental programs. This data model must be based on the requirements of the entire environmental staff, including resource managers, administrators, the support staff, and outside contractors who supply data to the shipyards. It will be a "living" model that is subject to change as new aspects of the environmental data requirements of the shipyards are uncovered. This data model should also be the foundation for the data reporting specification.

The shipyards should establish a dialogue with other organizations that are developing environmental data models or data reporting specifications. In particular, the shipyard should coordinate their data modeling efforts with SWDIV's Navy Environmental Data Transfer Standard (NEDTS).

REFOCUSING CURRENT PROGRAMS TO A RISK-BASED APPROACH

The shipyards' long-term goal should be to shift their environmental programs away from compliance based on water quality criteria towards an assessment of ecological risk posed by the shipyard's operations (see Appendix C). It seems logical and prudent to develop environmental monitoring programs based on important measures of ecological health. While regulatory requirements will likely change as a function of the program implemented, these important parameters should remain constant. The constancy of these measures will make them much more useful for the long-term management of resources in the estuary. Ecologically based programs will also address the public's specific concerns about environmental quality. Many of the recommendations made in the previous section are preparatory to achieving this goal. The present section discusses recommendations that are specific to developing a risk-based approach. The recommendations presented below will generally take longer and cost more to implement and will require broader support from regulatory agencies.

There is no mention of a risk-based approach to water quality regulation in the text of the NPDES, stormwater, or similar regulations. However, the following observations argue that an integrated, ecological-based approach meets the spirit and intent of protecting the environment under the CWA and associated regulations:

- EPA has been one of the primary driving forces to implement the ERA process within the regulatory framework of CERCLA.
- EPA and several State agencies are now encouraging integrated approaches to environmental regulations such as the following:
    - Ecosystem
    - Watershed
    - Multimedia
    - One-stop permitting
    - Contaminated Sediment Management Strategy
- EPA and State regulators are encouraging the regulated community to propose innovative solutions to pollution problems.

An example of this latter point is California's involvement of the regulated community and other stakeholders in the early planning and development of the Enclosed Bays and Estuaries Plan and Inland Surface Waters Plan. The State Water Resources Control Board is developing these plans to regulate water quality throughout the state. The MESO staff has participated in several task force technical discussions. There has been favorable response to innovative water quality regulation from regulators responsible for writing and enforcing permits. Some options that were discussed and considered for incorporation into the final State plans include the following:

- Replace the emphasis on effluents from individual dischargers with a comprehensive view of the marine environment by coordinating ambient monitoring for water bodies and watersheds.
- Permit voluntary participation in regional watershed studies and monitoring to give permittees regulatory relief through relaxation of individual permit requirements.

- Apply technology- and performance-based limits in cases where water quality limits are unachievable.

- Include more relevant monitoring in permits to replace emphasis on chemical concentrations in effluents with measures of ecological or biological effects.

- Consider the use of tiered monitoring approaches to make compliance programs more cost-effective and less enforcement-driven.

- Incorporate site-specific conditions and criteria for all programs rather than relying solely on the national criteria and standards adopted by the State.

Cost-effective compliance will require more scientifically relevant assessment methods and the implementation of control and remediation technologies that demonstrate improvements in marine environmental quality. Moreover, it will be essential to obtain concurrence from State and local regulators; In addition, public approval and participation, before successful implementation of these methods can be achieved. It is anticipated that the underlying environmental regulations will be modified to institute ERA as a compliance strategy once the federal and State regulators have accepted this approach. These trends notwithstanding, the acceptance of ERA has not occurred at all levels of the regulatory structure.

- The MESO staff will work with shipyard personnel to present to federal, regional, and State regulator arguments regarding the desirability of incorporating the results from an integrated approach to achieve compliance. Because of the sensitive nature of the relationship between the shipyards and their regulators, all contacts with regulators will be made through the respective facility commands. An integrated approach will be more protective of the aquatic ecosystem of each shipyard than the current approach to compliance because it will include the following elements:

    - Monitoring strategy focused on key ecological parameters that will not change as a function of regulatory requirements;

    - Assessment of the shipyard environment "footprint" as a whole rather than in fragments;

    - Better information for the long-term management of ecological resources;

    - Integration and partnership among regulators, the shipyards, and the public.

In refocusing towards a risk-based approach to marine compliance, the shipyards should continue to expand efforts with representative discharge monitoring and replacement monitoring. To support a comprehensive environmental assessment, the shipyards should begin to fill in any information data gaps identified. Monitoring efforts should be focused within a risk assessment framework to support the specific long-term monitoring plans that NRaD will develop in Phase IV.

The shipyards will require an integrated database of environmental measurement and supporting data to prepare their ERAs. This database will be:

- The foundation of the conceptual models of potential impacts;

- The repository for measurements gathered to test the hypotheses generated from the conceptual models;

- The mechanism for compiling and sharing data from other U.S. Navy and non-Navy sources;

- The basis for long-term monitoring the impact of changes in the shipyards' operations;

- Source of information needed to generate regulatory-required documents.

The database design must be based on a sound data model derived from the analysis of the shipyards' current and projected data requirements (see previous section). The shipyards can choose to implement their own local database, but all of these databases should be based on the same data model. Because a common data model is used, local databases must share a common key structure. Common keys will be required should the shipyards desire to link the individual databases into a distributed database that encompasses all the environmental programs at all the shipyards. The SLIMS database should be part of this distributed architecture.

The shipyards will also need to develop a data management plan including data quality standards for the database. This plan should outline the procedures for operating and maintaining an environmental database developed in accordance with the data model. The data management plan will, like the data model, be a "living" document that changes with the changing requirements of the shipyard environmental programs.

The general quality control program developed for the shipyards by NAVSEA should include a master Data Quality Objectives (DQO) and a Data Management Plan (see also section 9). These documents should set forth the general types of data to collect and the precision required for these data to quantify environmental status. The specific types and precision of analyses will vary between shipyards and among programs. Nonetheless, the general framework will help to ensure closer coordination of data collection, data reporting, and data management.

All primary measurement, supporting, and associated data collected by or for the shipyards should be loaded into the database in accordance with the data QA/QC procedures set for in the Data Management Plan. This would include data collected by all programs. The database can be used to generate reports, analyses, etc. for these programs at the same time the shipyard is using their data to argue for integrating the programs into a more coherent whole. All the data the shipyards obtain from other sources should also be stored in the database, although here the QA/QC procedures might have to be relaxed somewhat to accommodate missing data attributes. Any measurement data derived from hardcopy sources should be extracted using the data reporting specification and added to the database.

The shift to risk-based assessment will entail not only integrating and refocusing the shipyards' environmental programs, it will require a shift in their analytical methods. The environmental laboratories will need to shift the emphasis of their analytical methods to trace levels of the bio-available fractions of contaminants to sediments and tissues over water, and to biological and ecological effects such as toxicity, bioaccumulation, reproductive success, and community structure. Ecological risk assessments will require even more biological testing, including measures that are more directly related to biological and ecological interactions. Besides the EPA-approved bioassays, these additional tests might include molecular biomarkers, biochemical testing, and measures of community function and structure.

To realize the full benefit of this approach, the shipyards must make the public aware by educating them about the important issues and concerns of the shipyard environmental program. Effective outreach programs can be developed through the existing Community Relations Plans and Restoration Advisory Board members already established at the shipyards. Presently, these programs are focused on and funded by components of the IR program. With some changes in guidance and funding, they can be used on a larger shipyard scale. Public involvement bolsters the shipyard's

credibility as a responsible member of the environmental community and informs the public as to the progress and improvements in the shipyard's environmental programs.

Finally, implementing the recommendations presented in this report must be a gradual process. Shipyard personnel should be actively involved in determining the implementation priorities. Once those priorities have been established, NRaD will work closely with the shipyards to develop the details for implementing specific monitoring and data management options. While NAVSEA has tasked NRaD to guide the shipyards through this process, many recommendations will require additional money, time, and effort to implement. Part of the process of establishing priorities among the recommendations and developing implementation details for them will be to identify the resources needed to effect these changes.

1. INTRODUCTION

Naval Sea Systems Command (Code 073) tasked the Marine Environmental Support Office (MESO) at the Naval Command, Control and Ocean Surveillance Center (NCCOSC) RDT&E Division (NRaD), to assist the naval shipyards[1, 2] to formulate a marine environmental compliance strategy that ensures compliance with current and anticipated regulatory requirements. NAVSEA's goal is to develop a long-term, cost-effective strategy for marine and aquatic environmental compliance that integrates regulatory requirements and ecological science into a unifying framework.

Increasingly stringent environmental regulations are affecting operations at the naval shipyards, primarily because of the tightening of federal water pollution control over the past several decades. The first comprehensive legislation for water pollution control in the United States was the Water Pollution Control Act of 1948. This was followed by the Federal Water Pollution Control Act of 1956 and the Water Quality Act of 1965. The 1965 law mandated States to develop water quality goals, in the form of water quality standards (WQS), for interstate waters. Administrative problems, inadequate technology, and other problems hindered the States' success in implementing the law and its standards.

In 1972, Congress established the Federal Water Pollution Control Act, commonly referred to as the Clean Water Act, to "restore and maintain the chemical, physical, and biological integrity of the nation's waters." The act established two national goals to accomplish this objective: (1) achieve a level of water quality that "provides for the protection and propagation of fish, shellfish, and wildlife" and "for recreation in and on the water" by 1 July 1983; and (2) eliminate the discharge of pollutants into United States waters by 1985. The regulatory framework devised to achieve these goals included the following three elements:

1. Technology-based effluent limits establishing minimum treatment levels required by both direct discharges from Publicly Owned Treatment Works (POTWs) and indirect discharges from specific industries (pretreatment).
2. A program for imposing more stringent (than technology-based) limits in permits when necessary to achieve water quality standards or objectives.
3. A permit program called the National Pollutant Discharge Elimination System (NPDES) to implement water quality standards. This program required permittees to characterize and report their expected discharges, the EPA to specify and enforce limits on those discharges, and permittees to routinely report their compliance with those limits.

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[1] Long Beach Naval Shipyard, Norfolk Naval Shipyard, Pearl Harbor Naval Shipyard, Portsmouth Naval Shipyard, and Puget Sound Naval Shipyard.

[2] As of 23 June 1995, the Base Realignment and Closure (BRAC) Commission voted to close the Long Beach Naval Shipyard.

In the decade following the 1972 CWA, emphasis in water quality regulation was on technology-based effluent limits rather than water quality standards. This was, in part, because scientific efforts had not progressed far enough to develop the standards, and also because the States were reluctant to adopt numeric toxic pollutant criteria.

In 1980, the EPA published the first set of aquatic and human health water quality criteria (WQC) for 64 toxic pollutants. Thereafter, individual States were encouraged to adopt these criteria as their own water quality standards for protecting the environment, considering the designated uses of their specific water bodies. The EPA's national WQC are chemical-specific concentrations that were developed from laboratory bioassays. There are separate values for acute and chronic toxicity of freshwater and marine organisms. For the protection of human health from *carcinogens*, there are separate values for ingestion of fish only and fish plus water. Criteria also exist just for contaminant levels in drinking water. The EPA has always allowed States to prescribe their numerical WQS by: (1) adopting the national criteria, (2) modifying national criteria to reflect site-specific conditions, or (3) using other scientifically defensible methods (USEPA, 1994b).

When the original goal of achieving zero discharge of pollutants was not reached by 1985, and few States had adopted or developed numerical standards, Congress initiated work on new amendments to the CWA. The CWA was finally re-authorized in 1987. It placed stronger emphasis on the urgent need to shift from technology-based standards to water-quality based standards It also required the States to develop water quality standards for 126 specific toxic compounds (Arbuckle et al., 1991).

Additional environmental regulations related to CERCLA response actions, RCRA corrective measures, natural resource protection, and dredging have added to the complexity of marine environmental compliance. This complexity is evident in the exponential growth in the number of environmental laws (figure 1), and the complex web of regulatory requirements related to the marine environment (figure 2). The shipyards must be able to understand and comply with this complex interaction of regulatory programs to avoid administrative or legal actions that could potentially halt or adversely affect their operations.

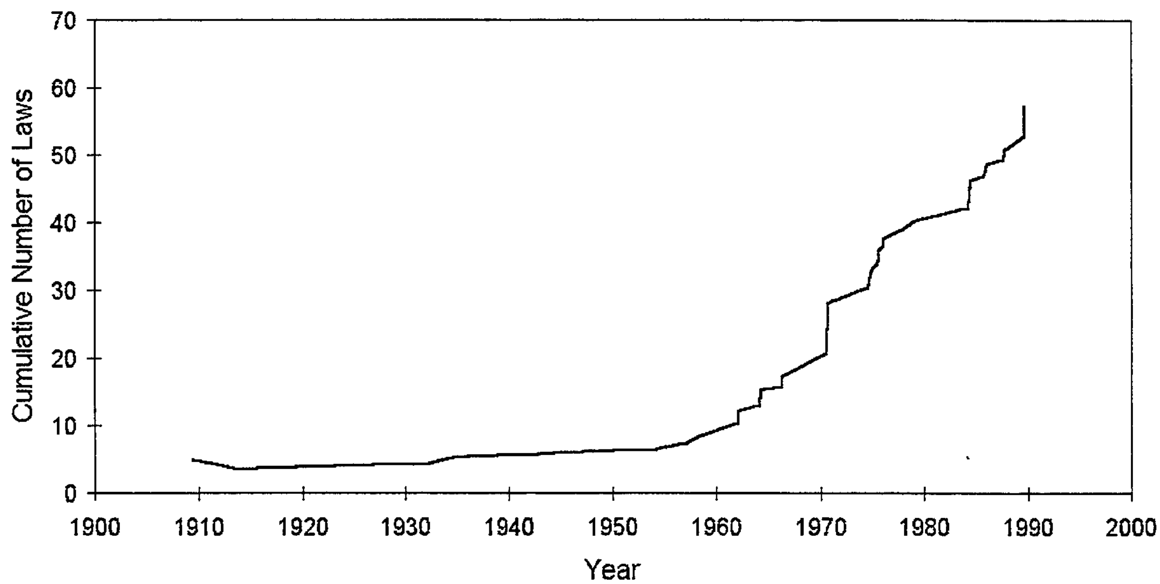

Figure 1. Growth of environmental laws. (Source: Briefing to U.S. Navy environmental managers by Sherri Goodman, DUSD for Environmental Security, Norfolk, VA, 29 Nov 1994.

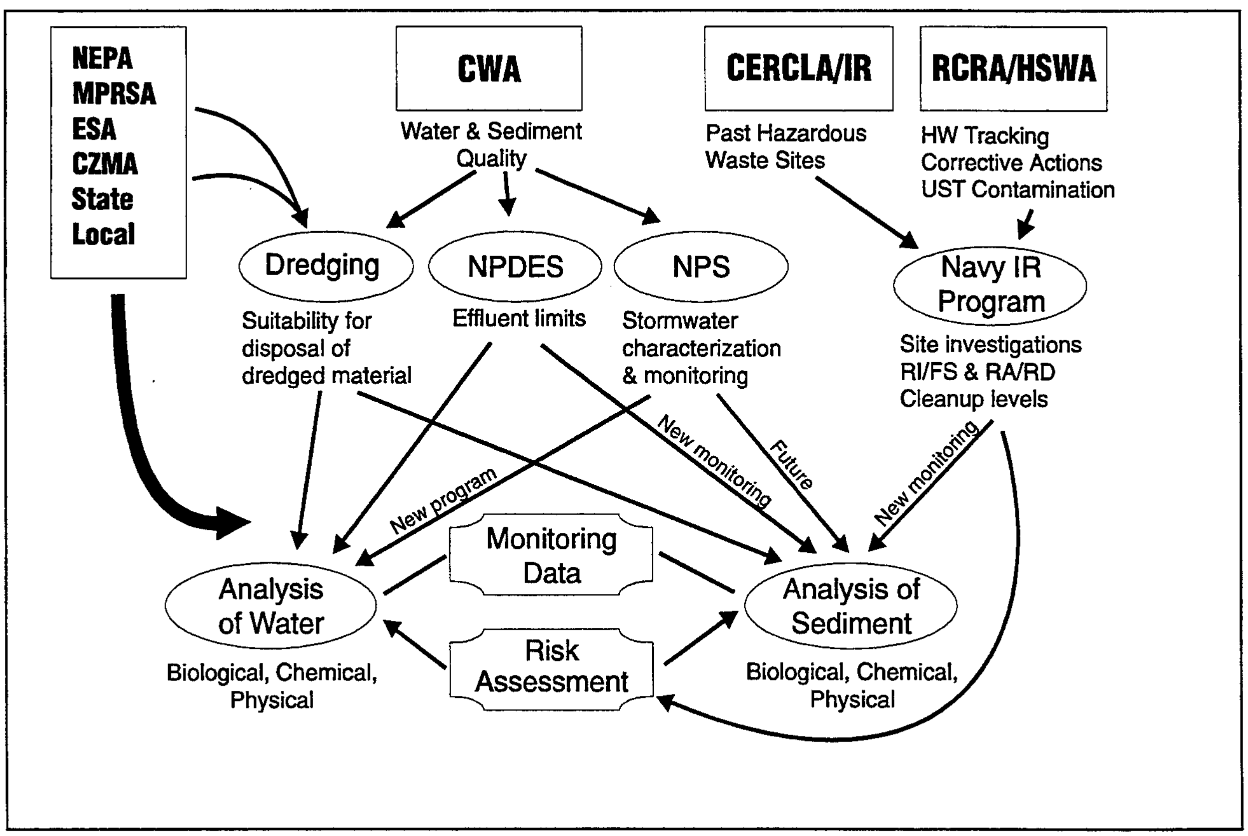

Figure 2. Monitoring requirements under current regulatory scheme.

In 1993, Mr. Robert Benze (Lead Shipyard Water Program Manager, NAVSEA 07E) wrote a discussion paper in which he argued that environmental compliance programs tend to be "compartmented into specific programs...although they may deal with the same affected media, all too often these separate programs are not integrated or coordinated" (Benze, 1993). The origins of this situation can be traced to the legislative mandates that created the programs. The fact that the shipyards have organized many of their environmental responsibilities in the same fashion is a logical outgrowth, but has only further exacerbated the situation. Consequently, shipyard personnel trying to comply with this complex set of regulations have often created parallel sampling and analysis programs with little or no coordination.

The U.S. EPA has developed a technical approach that will support this project's long-term objective of shifting the shipyards' environmental protection programs away from laboratory-derived, "end-of-pipe" water quality criteria towards an integrated multimedia approach. In 1992, EPA published guidance for conducting ecological risk assessment (USEPA, 1992c). In this context, an ecological risk is the evaluation of the likelihood that adverse ecosystem effects are occurring, or may occur in the future, as a result of exposure to one or more stressors (Bureau of National Affairs, 1995a; see also Appendix C of this report). A stressor is any chemical, physical, or biological factor that can induce adverse effects on any ecological component including individuals, populations, communities, and ecosystems.

While, in theory, risk-based assessments should provide a more realistic approach to environmental protection, they tend to be much broader in scope. Besides contaminant concentrations, they require knowledge of the physical, biological, and ecological processes governing the distribution and effects of these materials. They may also include sociological criteria for defining the environmental values to be protected (i.e., the "ecological endpoints"; Suter III, 1989). These factors expand the breadth of measurements the shipyards must undertake and the need to share measurement data between media, disciplines, programs, and agencies.

The shipyards must be aware of these evolving regulatory policies to respond appropriately. This can be a difficult task when shipyard personnel and resources are stretched thin simply complying with in-place regulatory requirements. Moreover, this policy shift will require the shipyards to prove that their operations do not pose an unacceptable risk to the marine environment, or alternatively, to propose methods of reducing a potential impact, should it exist. Both alternatives require sound, scientifically defensible data. They also require long-term monitoring data to evaluate the effects of discharges, cleanup actions, and other industrial operations over time. The challenge facing the shipyards will be to accommodate these changing requirements within existing environmental protection budgets while maintaining compliance with existing regulations.

The overall goal of this project is to provide a long-term, cost-effective, risk-based strategy for marine environmental compliance at naval shipyards. The objective of Phase I is to review the environmental compliance and data management programs at the five naval shipyards and recommend strategies and methods to integrate and strengthen them. There will be two kinds of recommendations made throughout this report:

- Short-term recommendations to assist the shipyards to achieve marine environmental compliance under the current regulatory scheme.
- Longer term recommendations to guide the shipyards in refocusing their programs towards a more relevant, risk-based ecological monitoring approach.

The major objectives of the follow-on Phases II through IV will be as follows:

- Work closely with the shipyards and their respective regulatory agencies throughout the entire project to help implement the recommendations made during Phase I.
- Continue to provide short-term assistance to the shipyards in achieving marine environmental compliance under current regulatory schemes.
- Develop a data model and a data reporting specification to ensure the shipyards capture fully documented environmental measurement data in electronic form; and assist the shipyards to use the data model to support their environmental compliance programs and to plan future shifts in regulatory policy.
- Critically review past and ongoing ecological risk case studies to determine the appropriate state-of-science methods that should be used by the shipyards in an ecological risk-based approach to marine compliance.
- Develop a data management plan the shipyards can use as the basis for specifying, evaluating, managing, using, and archiving environmental information.
- Prepare a risk-based long-term monitoring plan for each shipyard to help the shipyards achieve long-term marine environmental compliance within the risk assessment framework.
- Create a guidance manual that will enable all shipyards to implement their respective monitoring plans.

2. METHODS

Phase I of this study was designed to gather and analyze information about the marine environmental compliance programs at the naval shipyards by:

- Determining the nature and the scope of individual compliance programs at each shipyard;
- Determining the effectiveness of existing programs for addressing environmental risk;
- Comparing programs between shipyards, highlighting effective approaches to compliance, and identifying problem areas;
- Using these analyses to make recommendations for improving the ecological relevance, management, and cost effectiveness of monitoring programs.

A team of environmental specialists from MESO collected information for these analyses during on-site visits to the five naval shipyards. Before the site visits, a questionnaire was developed to gather background information (Appendix B). The questionnaire was organized into two parts:

Part One: General Questions

Water & Sediment Quality Standards

Regulatory Agency Interface

Characterization of Water Body/Ecosystem

Specific Contaminants

Applicable Programs

Part Two: Specific Programs

NPDES Point Source

Non-Point Source/Stormwater

Dredging

CERCLA/Installation Restoration of Hazardous Waste Sites

HSWA/RCRA Corrective Actions for Contaminated Sites

HSWA/UST Past Contamination of Underground Storage Tanks

OTHER: monitoring done under any other project or program not listed:

- Natural Resources Management
- Oil and Hazardous Substances Spill Response

NAVSEA contacted the five shipyards in advance and advised them of the program and its objectives. The MESO staff then contacted the environmental management personnel at the shipyards to coordinate the site visit. The questionnaire was sent to the shipyards to gather

background information from the environmental personnel, along with a draft agenda for the site visit. Follow-up telephone calls resolved outstanding issues from the questionnaire and/or agenda. MESO independently collected and reviewed navigational charts, site assessment reports, and other information before the visits.

During the site visits, the MESO team met with program managers for the NPDES, Stormwater, Installation Restoration, RCRA, Underground Storage Tanks, Oil and Hazardous Substance Spill Response, and Dredging programs. The questionnaire and the shipyard's response served as a framework for the information gathering activities during these visits. MESO personnel reviewed and made photocopies of regulatory permits and correspondence, reports, and other relevant documentation at the shipyard. The team toured each site to observe the ecological setting, dry-dock operations, permitted and unpermitted discharges, and areas subject to non-point source runoff. The MESO team interviewed a wide range of individuals, including the environmental staff, docking officers, directors/supervisors of the industrial chemistry laboratory, industrial waste/bilge water treatment plants, and computer systems or data management specialists. The MESO team also collected information from external sources to consider other environmental data resources, and to understand the perception of the U.S. Navy's environmental programs by adjacent communities.

Upon returning to San Diego, the MESO team prepared a trip report for each shipyard. These reports organized and summarized information gathered at the shipyard. They also guided the techniical support MESO has provided to the shipyard environmental managers during Phase I of the project. The heads of the Environmental Division at each shipyard reviewed a draft of the trip report for their shipyard. Mr. Robert Benze (Lead Manager, NAVSEA Water Quality program) and Mr. David Kopack (NAVSEA 07E) reviewed a draft copy of the trip reports for all of the shipyards.

The MESO staff used the following materials to prepare the analysis of the shipyards' environmental programs for this report:

- Trip reports
- Reports and other information collected during the site visits
- Telephone re-interviews of some environmental program managers to clarify outstanding issues
- Reviews of current and proposed environmental regulations and policies.

MESO's analysis of shipyard marine compliance programs produced categories that differed slightly from the organization of the original questionnaire. This Phase I report analyzed the following laws, regulations, and implementation programs at each shipyard:

- Clean Water Act/NPDES[3] Point Source
- Clean Water Act/Non-Point Source/Stormwater

[3] Both the shipyards and NAVSEA view NPDES as the most problematic marine compliance program. Consequently, NPDES was the primary focus of Phase I analysis and receives the most attention in this report.

- Installation Restoration

  IR/CERCLA

  IR/RCRA

  IR/UST

- Dredging

- Other Regulatory Programs:

  Processing of Industrial and Oily Waste

  Natural Resources Management

  Oil and Hazardous Substances Spill Response

- Processing of Environmental Samples

- Environmental Data and Information Management Systems

Section 3 of this report describes the environmental setting at the five shipyards. The major regulatory programs at each shipyard are then reviewed in sections 4 through 8. This review includes background materials and a detailed analysis of the current programs at the shipyards. The analysis is followed by a series of recommendations that are specific to each regulatory program. Similarly, sections 9 through 10 discuss the status and recommended integration of two important support functions: data management and environmental testing laboratories.

3. ENVIRONMENTAL SETTINGS

INTRODUCTION

This chapter includes a brief description of the environmental setting for each of the five shipyards that were visited. These descriptions are included because it is important to understand the geographical location and the ecological and natural resources in and around the shipyard. It was not always possible, however, to provide uniform descriptions of each shipyard because of the variable amount of information available.

LONG BEACH NAVAL SHIPYARD

General Site Description

The Naval Shipyard Long Beach (LBNSY) is located (Latitude: 33° 45.30' North, Longitude: 118° 13.50' West) within the Los Angeles and Long Beach Harbor districts of California, approximately 24 miles south of downtown Los Angeles. It is immediately east of the Naval Station Long Beach and on the south side of Terminal Island (figure 3). Commercial shipping, bulk liquid handling, and heavy industrial and commercial fishing activities take place on Terminal Island west of the naval facility. The area north of the naval shipyard is used for oil production activities. The Southern California Edison Long Beach Generating Plant is located on the eastern end of the island (EFD Southwestern, 1993a).

The Los Angeles/Long Beach Harbor complex is the major surface water body near Long Beach Naval Shipyard. The shipyard itself is located in the West Basin of Long Beach Middle Harbor. The primary use of the West Basin of Long Beach Harbor is for U.S. Navy berthing and other shipping activities. There is also a small craft marina in the southwest corner (EFD Southwestern, 1993a). The shallow groundwater and the surficial deposits are both influenced by saltwater intrusion. Reportedly, investigations at Terminal Island show the mineral content of the groundwater in the shallow zone is comparable to that of seawater and is considered non-potable. The groundwater is not used as an industrial water source.

Local groups have focused much attention on the naval facilities in Long Beach because the Long Beach Naval Station is on the Base Realignment and Closure (BRAC) list and the shipyard is proposed for the next round of base closures. This has brought the specific issues of land use and cleanup standards into consideration.

Ecological Resources

The aquatic fauna in the harbor includes invertebrates such as polychaete worms, crustaceans, and mollusks. Fish, including species consumed by birds and humans, are also present (EFD Southwestern, 1993a). Terrestrial wildlife is uncommon at the shipyard because it and the surrounding environments are highly industrialized. Little or no natural, undisturbed terrestrial habitat exists. There are no sensitive terrestrial environments identified near the shipyard (EFD Southwestern, 1993a).

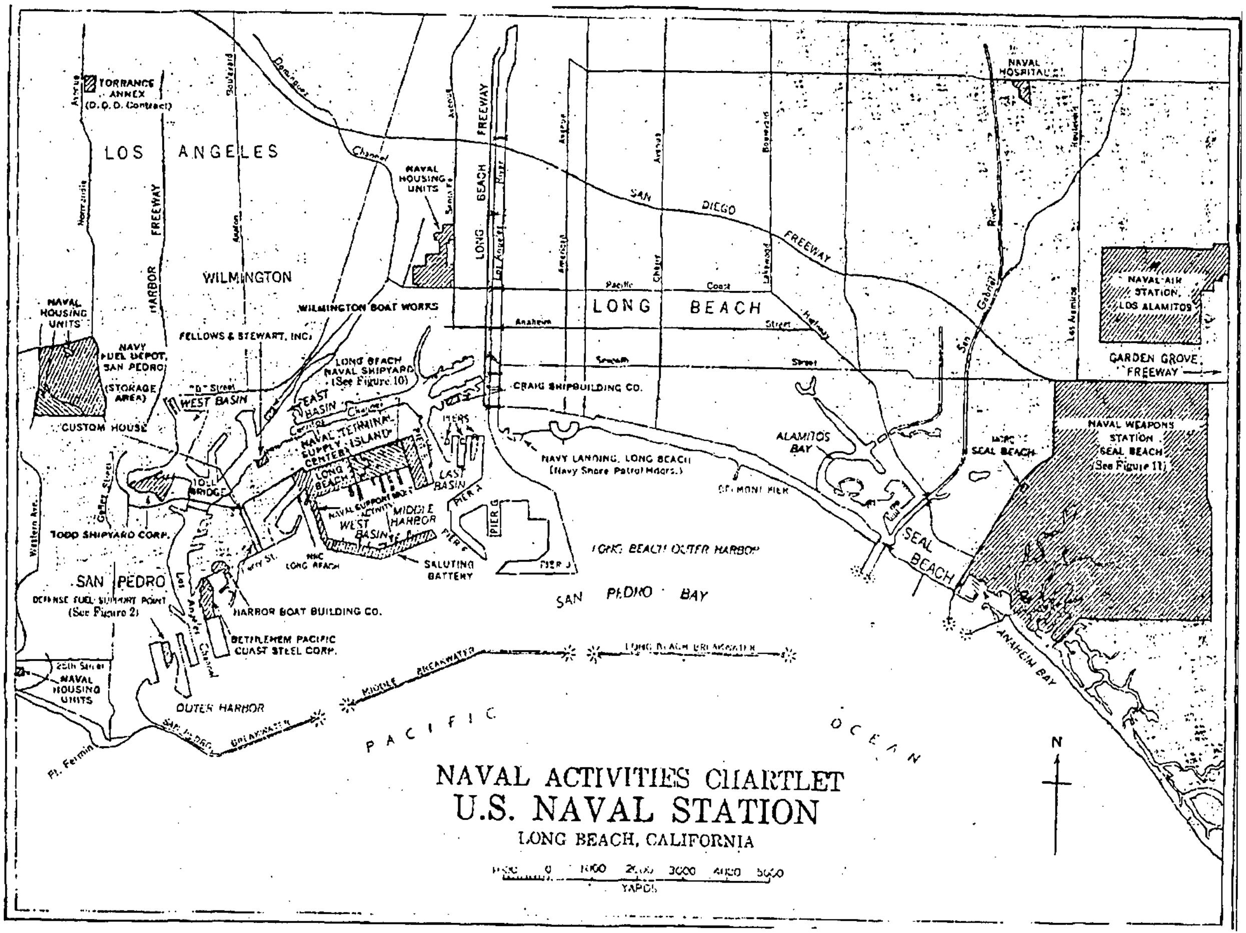

Figure 3. Long Beach Naval Shipyard.

General Water Quality

The Los Angeles–Long Beach Inner Harbor areas have been designated as Water Quality Limited (WQL; LBNSY NPDES permit). A WQL Segment is any segment where it is known that water quality: (1) does not meet applicable water quality standards, and (2) is not expected to meet water quality standards even after the application of the effluent limitations required by the Clean Water Act (California State Water Resources Control Board, 1987). The WQL Segment classification is established pursuant to federal regulations and only pertains to surface and coastal waters.

Since the Los Angeles–Long Beach Harbor is a water body surrounded by urban and industrial development, there are many sewage treatment and waste treatment plants that discharge into the inner harbor. Health warnings are in effect because the concentrations of chlordane, DDT, and PCB found in tissue exceed U.S. Food and Drug Administration action levels (California State Water Resources Control Board, 1987). The harbor area is not used for recreational swimming. Shellfish in the harbor show signs of contamination and health warnings about consuming finfish from the harbor are often posted. Recreational fishing is, however, common off the Mole Pier and other areas within the West Basin of Long Beach Harbor (EFD Southwestern, 1993a).

PORTSMOUTH NAVAL SHIPYARD

General Site Description

Portsmouth Harbor, a natural harbor formed by the mouth of the Piscataqua River, is the approach to the Portsmouth Naval Shipyard (PNSY) on Seavey Island (Latitude: 43° 4.50' North, Longitude: 70° 44.0' West). Seavey Island is northward of the Piscataqua River axis and midway between New Castle Island and Portsmouth, New Hampshire. The island is 0.25 miles in length along the northwest-southeast axis, and approximately 0.6 miles wide at its widest breadth (figure 4).

The Great Bay Estuary is a complex waterway composed of Piscataqua River, Little Bay, and Great Bay. It is a tidally dominated system that includes the drainage confluence of seven major rivers, several small creeks and their tributaries, and ocean water from the Gulf of Maine. The landscape viewed from the shipyard across the bay is forested upland away from the rocky shore (Short, Jones, Sale, and Wellenberger, 1992). The area surrounding the shipyard and Portsmouth Harbor is scenic. It includes Kittery Point and Gerrish Island in Maine, and New Castle and Pierces Islands in New Hampshire. Portsmouth Harbor is the only deep-water harbor in New Hampshire. Heavy traffic consists of oil barges and submarines operating at the shipyard, and tugs and ships operating out of the New Hampshire Port Authority Cargo Terminal. Fishing trawlers, lobster boats and recreational vessels are also frequently present in the estuary. The Great Bay and Piscataqua River estuarine system extends about 20 to 25 miles into New Hampshire and is fed by seven different rivers. Much of the estuarine shoreline is undeveloped, but industrial activities in southeast New Hampshire, such as foundries and tanneries, discharged wastes into the estuary, especially from 1940 to 1976. The tidal currents in Portsmouth Harbor are extremely strong and periods of slack water are very short. The estuary is generally well-mixed, with a salinity gradient from the mouth of the harbor to the tributary rivers. Freshwater is found upstream of the old mill dams on the tributary rivers (Munns, Jr., Johnston, Short, and Walker, 1994).

Local community awareness is high regarding environmental issues at the shipyard. While some concern about ongoing shipyard activities exists, shipyard personnel believe they have promoted a favorable public image in the region and public opinion is generally supportive of the U.S. Navy's programs. The shipyard is a major employer in the local economy. Thus, there is also concern whether the shipyard will be added to the BRAC list of base closures.

Ecological Resources

The Great Bay Estuary has an abundance of benthic invertebrates, primarily polychaetes, crustaceans, bivalves, and gastropods. The eelgrass and saltmarsh habitats provide valuable resources for fish. There has been a loss of eelgrass habitat over the years mainly because of a catastrophic decline known as the wasting disease. (Short, 1992, p.154).

The diverse population of birds within the Great Bay Estuary includes seabirds, waterfowl, wading birds, shore birds, saltmarsh birds, and birds of prey. Mammals that live around the estuary include raccoons, whitetail deer, red fox, woodchuck, muskrats, squirrels, cottontail rabbits, beavers, and otters (Short, 1992). There are several endangered and threatened bird species, including the bald eagle, common tern, upland sandpiper, and common loon.

General Water Quality

The Piscataqua River has been classified as Water Quality "B" by the State of New Hampshire (Short, 1992) and as Water Quality "SC" by the State of Maine (PNSY NPDES permit)[4]. The estuary supports 52 species of commercially and recreationally important finfish, including both resident and migratory species (Sale, Guy, Langan, and Short, 1992, p. 114). Sewage contamination sometimes causes the estuary to be closed to shell fishing (Munns et al., 1994).

There are many permitted discharges into the estuary. The largest volume of discharge comes from many municipal sewage treatment plants serving communities next to the estuary. Industry adds pollutant and thermal stress to the estuary. The primary chemical stressors of concern include heavy metals and organic compounds such as polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) (Johnston, 1994).

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[4] The Water Quality classification is a scale of "A"—support and enhance designated use, "B"— support designated use, and "C"—does not support designated use, which is set by the States and based on the EPA guidance issued for preparation of a 305(b) report. The Water Quality classification in Maine is a scale of SA to SC for Estuarine and Marine Waters. "SC" defined as Recreation in and on the water ... restricted harvesting of shellfish....

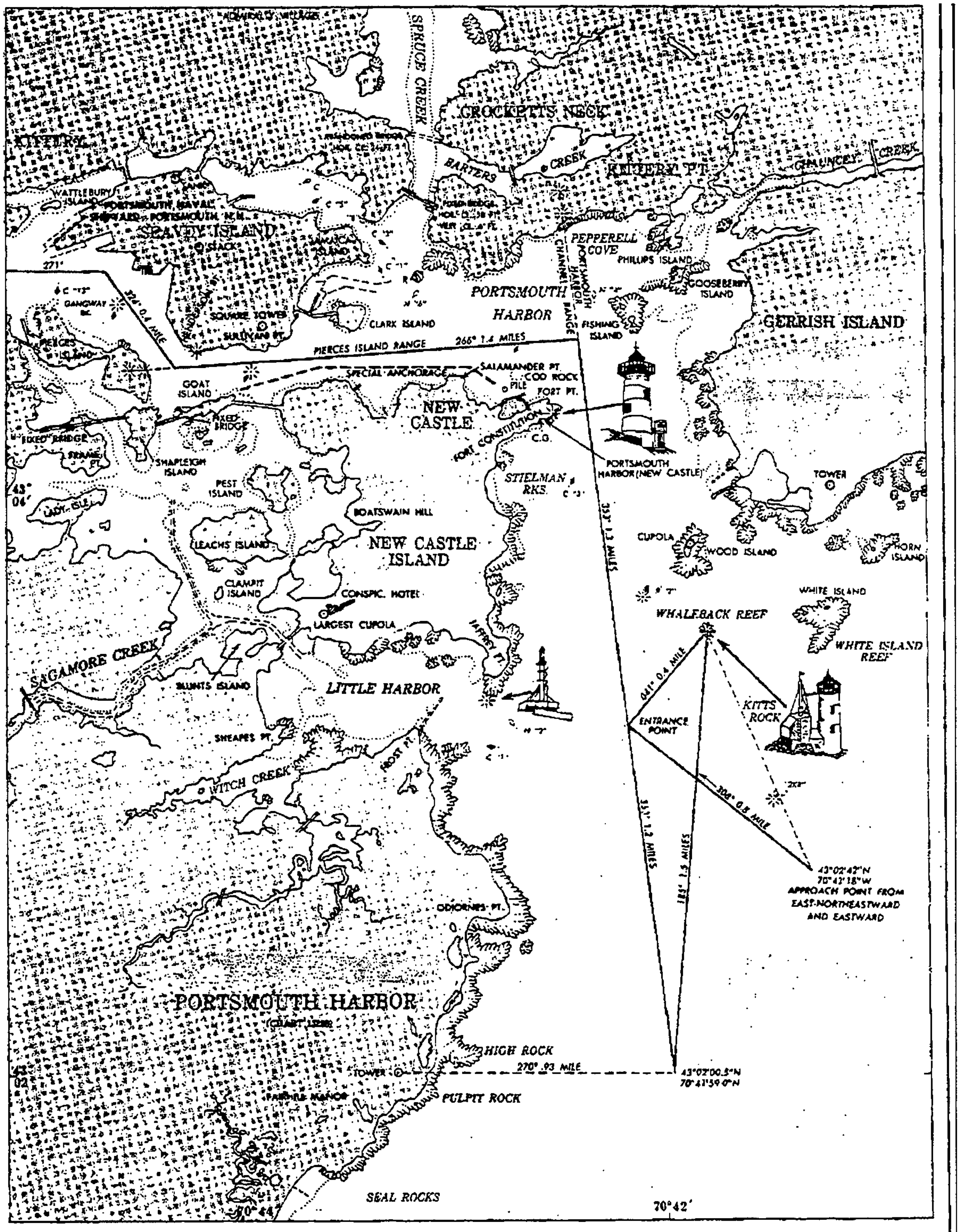

Figure 4. Portsmouth Naval Shipyard.

PUGET SOUND NAVAL SHIPYARD

General Site Description

The Naval Shipyard Puget Sound (PSNSY) is located (Latitude: 47° 34.0' North, Longitude: 122° 38.0' West) next to Bremerton, WA. The shipyard occupies most of the northern shore of Sinclair Inlet, an arm of Puget Sound west of Seattle. Sinclair Inlet is 3.4 miles long, 1.4 miles wide at the widest point, and has a depth of 30 to 50 feet (figure 5). The inlet also includes a large inactive ship facility comprising several large fleet units. The city of Bremerton adjoins the shipyard along its eastern and northern boundaries, and the municipal sewage outfall empties into the Sinclair Inlet west of the shipyard (Grovhoug, Fransham, and Seligman, 1987). The Bremerton Ferry Terminal is immediately east of the shipyard in the city of Bremerton. The town of Port Orchard is situated along the inlet's southern shore, across from the shipyard. A float landing, ferry pier, and two marinas with berths for 500 or more vessels are located at Port Orchard.

Puget Sound, including Sinclair Inlet, are marine water bodies. There are 95 miles of marine shoreline in Kitsap County, with 3 miles along the naval complex.

The surface water temperature ranges from 47.3°F to 64.4°F and averages 3.1°F higher than waters from a depth of 33 feet in Sinclair Inlet (EFA Northwestern, 1994). The magnitude of the surface warming suggests that vertical mixing rates are low.

The geologic strata within Kitsap County form two distinct aquifers. The elevation of the upper aquifer ranges from mean sea level to 200 to 300 feet above sea level. The elevation of the lower aquifer ranges from above mean sea level to about 300 feet below sea level. Groundwater within these aquifers is easily reached through the overlying strata composed of a sand and gravel layer formed by glacial outwash and alluvium. No perennial streams or freshwater bodies are located within the shipyard boundaries. The volume of freshwater entering Sinclair Inlet from precipitation and runoff along the western edge (head of the Sinclair Inlet) is low compared to the saltwater input from tidal flow (EFA Northwestern, 1994).

The local community is very aware of environmental activities at the shipyard. The primary concern of the public is whether the shipyard is affecting salmon production by trapping the small fish they feed on in the dry-docks. The shipyard has issued a fish entrainment instruction to address this issue. In addition, a local environmental activist group, the Puget Sound Alliance, has sued the shipyard on alleged violations of water quality standards.

Ecological Resources

The marine flora found in the inlet includes variants of green, red and brown algae, and eelgrass. Eelgrass beds located in nearby Dyes Inlet provide a herring-spawning habitat. The marine fauna may transit through or reside within the offshore boundary of the shipyard. The altered near-shore zone at the shipyard would be considered unsuitable habitat for juvenile chum and Chinook salmon during their early marine residence because of the lack of productive, shallow-gradient intertidal areas (EFA Northwestern , 1994). Several species of salmon and other anadromous fishes use the tributaries of the inlet for spawning, although Sinclair Inlet is not considered a major Puget sound migration pathway (EFA, Northwestern , 1994). The marine organisms include benthic and epibenthic filter feeders, detritus-feeding invertebrates including crabs and sea cucumbers, bottom-dwelling and bottom-feeding fish.

Most of the mammals inhabiting the shipyard are small, such as shrews, mice, rabbits, squirrels, and moles. Reptile and amphibian life predominantly consists of garter snakes, turtles, salamanders, newts, and frogs. Threatened, endangered and sensitive species include the bald eagle, great blue

heron, and game species of waterfowl. There are no threatened or endangered species at the shipyard (EFA Northwestern, 1994).

General Water Quality

The marine surface waters of Dyes and Sinclair Inlets are rated as "Class A" Water Quality segments by the Washington State Department of Ecology (EFA Northwestern, 1994). The State's water quality standards describe "Class A" marine surface waters as having general water quality characteristics that meet or exceed the standards for all uses.

Shell fishing in Sinclair Inlet is prohibited because of POTW and raw sewage (from individual septic systems, etc.) discharges. Outside the POTW and other sewage discharges, other non-Navy potential sources of historical contamination include gas stations west of the shipyard. The main pollutant stressors of concern are copper and PAHs (EFA Northwestern, 1994).

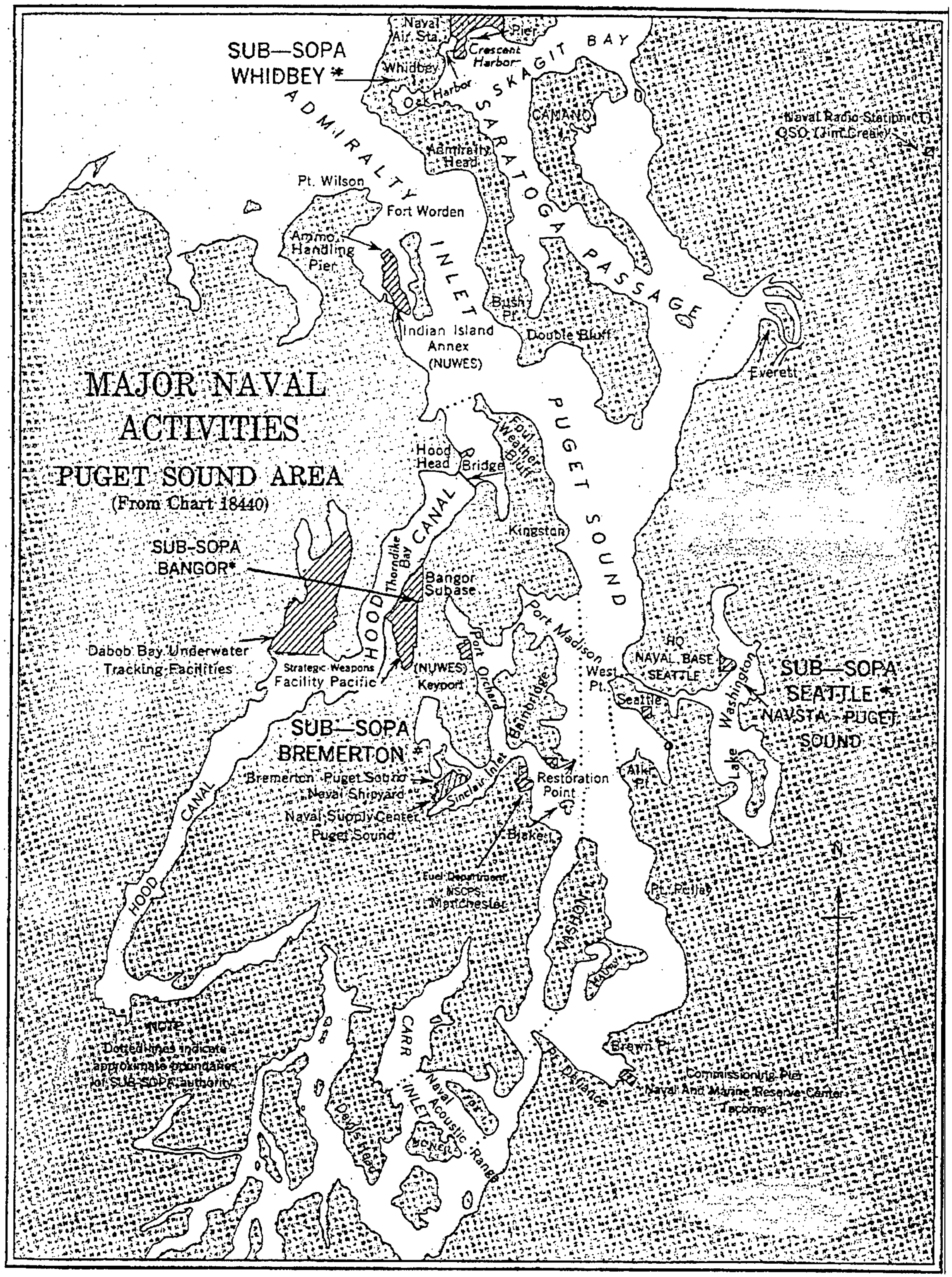

Figure 5. Puget Sound Naval Shipyard.

NORFOLK NAVAL SHIPYARD

General Site Description

The Naval Shipyard Norfolk (NNSY) is located (Latitude: 39° 49.0' North, Longitude: 77° 18.0' West) in Portsmouth, Virginia, on the southern branch of the Elizabeth River. Hampton Roads, the joining of the James River estuary and the Elizabeth, Nansemond, and Lafayette Rivers, is the center of the largest concentration of military and civilian shipping activities on the East Coast of the United States, with over 30 nautical miles of improved waterfront facilities (figure 6; Grovhoug et al., 1987). Commercial shipping heavily uses the Hampton Roads region.

A community group known as the Elizabeth River Project is working toward a goal of restoring the environmental and ecological health of the Elizabeth River. The project is an informal assemblage of government regulators, military and industrial representatives, university researchers and professors, environmentalists and private citizens. In a report by this group, the shipyard was specifically designated as one of many polluters of the River (Elizabeth River Governing Board, 1991). The report also specifically discussed sediment contamination and other water quality problems in the river that relate to the shipyard.

There are four aquifers in the area of the shipyard. Two of these are freshwater aquifers, and two deeper aquifers are generally brackish in water quality. Reportedly, the two freshwater aquifers are not used for potable sources near the shipyard. The southern branch of the Elizabeth River is a tidal estuary. It flows north from the shipyard approximately 10 miles before joining the James River. The James River empties in to Chesapeake Bay about 2 miles from the point where the James and Elizabeth Rivers converge. The Atlantic Ocean is less than 20 miles from the point where the James River discharges into Chesapeake Bay (Elizabeth River Governing Board, 1991).

Ecological Resources

Finfish in the Elizabeth River (primarily in the Southern Branch) show obvious signs of stress and/or disease, especially among those species exposed to the contaminated bottom sediments (Virginia Water Control Board, 1992). Land development along the banks and dredging in the river has eliminated much of the natural pollutant buffering capacity of the watershed.

Herons, egrets, ducks, hawks, shorebirds, and muskrats inhabit the Paradise Creek and St. Julien's Creek Annexes, which are near Naval Shipyard Norfolk. Threatened or endangered species are unlikely to be found on the shipyard and its annexes given the extent of industrial and residential development (Elizabeth River Governing Board, 1991).

General Water Quality

Historically, the Elizabeth River has exhibited poor water quality and the State of Virginia has classified the river as Water Quality Limited. Restrictions on shell fishing in the waters surrounding NNSY are because of historical contamination of the sediments with toxic materials such as chromium, zinc, and copper (Virginia Water Control Board, 1992). There is potential contamination with fecal coliform bacteria from non-point source runoff (Virginia Water Control Board, 1992). The main stressors for the Elizabeth River are PAHs, heavy metals, and nutrient loading.

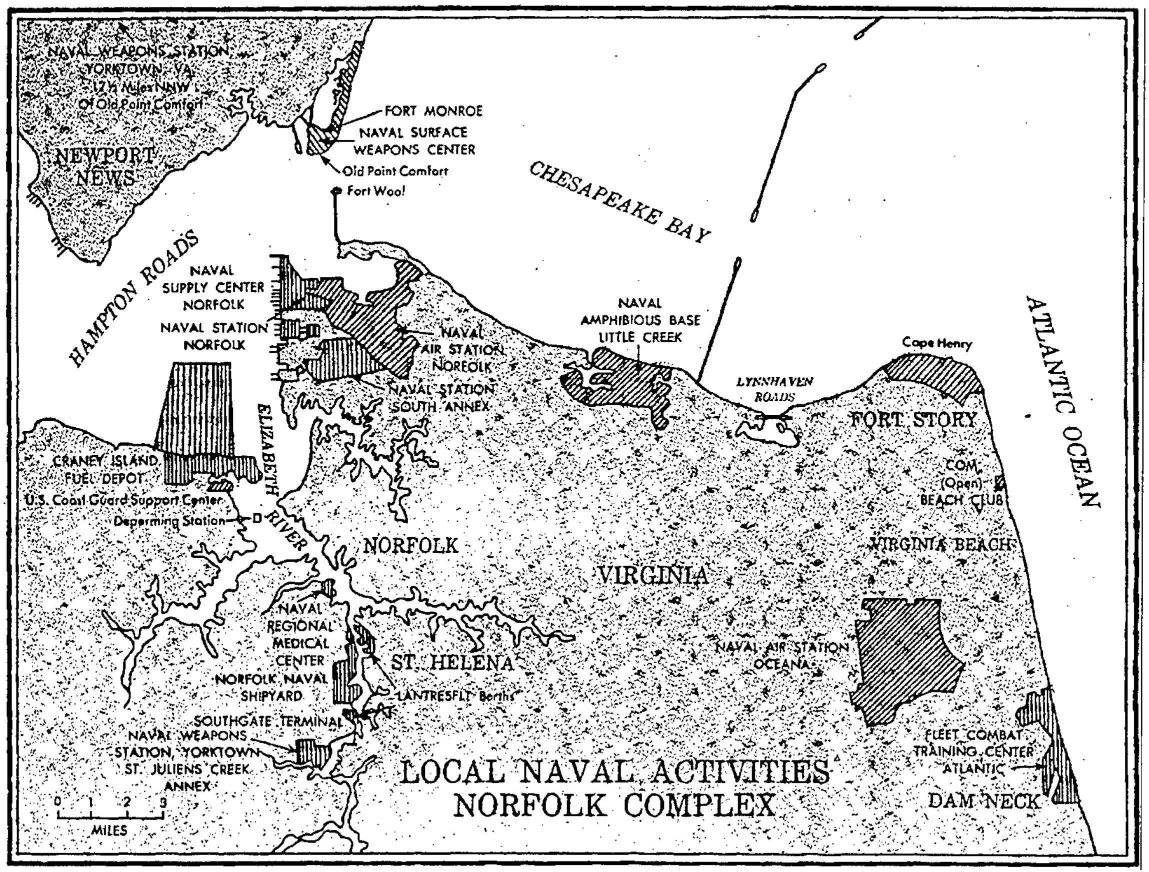

Figure 6. Norfolk Naval Shipyard.

PEARL HARBOR NAVAL SHIPYARD

General Site Description

Pearl Harbor is located in Hawaii, midway along the southern side of the island of Oahu (Latitude: 21° 21.0' North, Longitude 157° 57.0' West). The entire harbor is under the jurisdiction of the U.S. Navy and contains a naval shipyard, naval station, submarine base, Fleet Industrial Supply Center (FISC), and an inactive ship maintenance facility. Pearl Harbor is divided into three primary regions: East, Middle, and West Lochs (figure 7). Adjoining East Loch is the smaller Southeast Loch basin, which is, along with the adjacent areas, the most heavily used area within the harbor. Civilian vessels visiting the harbor include freighters and tankers to the FISC piers (next to Southeast Loch), tuna fishing boats collecting baitfish, and daily commercial harbor tour vessels from Kewalo Basin in Honolulu. Rainbow Marina, a small boat facility with a capacity of about 70 vessels, is located in the Aiea Bay area in the northeastern corner of East Loch (Grovhoug et al., 1987).

Tidal flow and circulation are weak and variable in Pearl Harbor. The mean tidal current velocity at the harbor entrance averages less than 0.3 knots, with a maximum velocity of 0.6 knots (U.S. Department of Commerce, 1986a; 1986b). Surface water circulation is primarily driven by the predominant northeasterly trade winds. The mixed tides have a mean range of 1.2 feet (0.4 meters). Freshwater inputs are irregular and occur from the discharge of eight major streams, which drain stormwater runoff into West, Middle, and East Lochs. Measured salinities in the harbor during a previous survey ranged from 14.1 to 37.5 parts per thousand, with an average of approximately 32.8 parts per thousand. The drainage area of the harbor is approximately 110 square miles.

Ecological Resources

The harbor serves as an important nursery ground for many marine species (Grovhoug et al., 1987). Several important commercial near-shore fish species frequent the harbor, particularly within the North Channel, Middle Loch, and Entrance Channel regions. Pearl Harbor sustains economically important bait fisheries, predominately based on the Hawaiian anchovy. The harbor has high biological complexity and productivity, with occasional red tide blooms. Biological patchiness occurs throughout different regions of the harbor, with the most stressed communities in Southeast Loch, Middle Loch, and the areas of the main channel adjacent to the shipyard. Plankton and larval fish populations are generally diverse. The harbor bottom consists primarily of gray or black mud and silt, with coral rubble, gravel, sand, and mud present along the sides of dredged channels. Live corals are absent from the harbor, although a fringing coral reef is located outside the entrance to the harbor.

Critical estuarine feeding and nesting habitats for three endangered species of birds exist in the area surrounding West Loch; these include the Hawaiian stilt, the Hawaiian gallinule and the Hawaiian coot (Grovhoug et al., 1987).

General Water Quality

Pearl Harbor is identified by the Hawaii Department of Health as a Water Quality Limited Segment in accordance with 305(b) of the Clean Water Act (PHNSY NPDES permit). The primary pollutant stressors for Pearl Harbor are PAHs, heavy metals, and nutrient loading (Grovhoug et al., 1987).

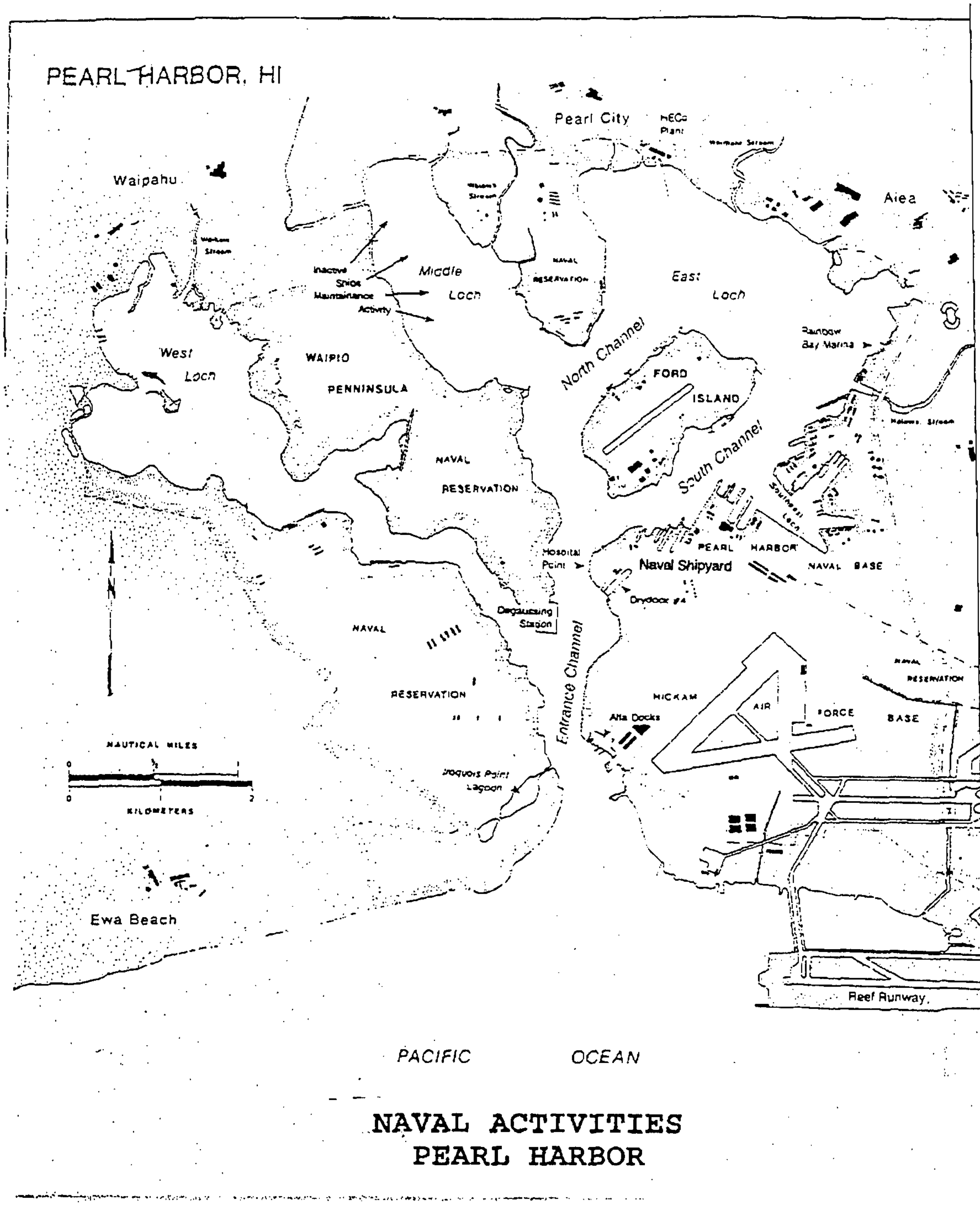

Figure 7. Pearl Harbor Naval Shipyard.

4. NPDES PROGRAMS

INTRODUCTION

The following quotation from the *Environmental Law Handbook* best describes the changing regulatory conditions of the National Pollutant Discharge Elimination System (NPDES) under which the naval shipyards must operate:

> "Until recently, NPDES permits normally specified four or five pollutants as being subject to effluent limitations; a far greater number are now included in permits as a result of EPA's toxics strategy. EPA's NPDES permit application and related regulations require extensive waste stream analysis in order to file permit applications, extensive cataloging in the application of virtually all chemicals in the waste stream, and imposition of controls on the discharge of those chemicals. Implementation of these requirements complicates the permit process and requires more extensive monitoring than was true in the past." (Arbuckle et al., 1991).

The national trend toward increased monitoring requirements is best exemplified by the gradual addition of toxic pollutants such as metals and organics to conventional water quality parameters such as flow, temperature, and turbidity. The five naval shipyards surveyed represent a broad spectrum of this changing regulatory climate (table 1). Portsmouth remains at one end of this spectrum, with requirements to monitor only six parameters at five dry-dock outfalls. At the other end, Norfolk has 15 different monitoring schemes for over 100 identified and characterized outfalls. If the trend continues, Portsmouth and other relatively unaffected dischargers will eventually hold NPDES permits that resemble that of Norfolk Naval Shipyard.

This section is organized into three major subsections:

- Technical issues on national NPDES regulations and how they affect compliance at shipyards;
- A detailed analysis of the NPDES programs at each shipyard, focusing on current strategies to reduce pollutants, compliance status, and specific permit conditions and requirements;
- Conclusions and recommendations that discuss opportunities for permit improvement and emphasize integration of marine environmental compliance under ecological risk assessment.

TECHNICAL ISSUES IN NPDES PERMIT REGULATION

The following issues were evident from MESO's review of the national NPDES program and surveys of the shipyards' NPDES programs:

- Application of more stringent effluent limitations;
- Lack of hydrodynamic mixing and transport models for water bodies;
- Slow development of site-specific criteria in regional water quality regulation;
- Inconsistencies in application of criteria, methods, and limits for trace metals;
- Scarcity of sediment monitoring in permits;
- Absence of ecological significance in required monitoring;
- Non-availability of standard analytical methods for aquatic trace pollutants.

Table 1. Monitoring parameters and periodicities summary.

Shipyards &	Conventional Water Quality Parameters																	Toxic Pollutants																Other				
																		Metals												Organics								
Outfalls	F	T	pH	FC	S	Tu	DO	BOD	COD	TOC	O/G	P	TN	NOx	NH3	Cl	M	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn	Fe	Sn	Pes	TTO	PAH	PCB	CN	TBT	TOX	Bio	Sed
Long Beach																																						
-Drydocks					M	M					M					M		S(t)	S(t)	S(t)	S(t)	S(t)	S(t)	S(t)	S(t)	S(t)	S(t)			A5					A	Q	A	A
Portsmouth																																						
-Drydocks	M		M		M						M																											
-Power Plant		D	M		M																																	
-Tank Farm	M		M		M																											A						
Puget Sound																																						
-Drydocks	W	M								M	W										W(t)	M(t)	M(t)				M(t)						M			Q(w)		IR
-Power Plant	C	D	D		3/w						D					D				W(t)							W(t)											
-Ambient																					Q(t/d)						Q(t/d)											
Norfolk																																						
Drydocks	M		M	Q	Q					Q	Q	M	M		Q				Q(t/d)	Q(t/d)	Q(t/d)	Q(t/d)	A(t)			Q(d)	Q(t/d)											
IWTP		D	D		W					W	W	W		W			W		W(t)	W(t/d)	W(t)	W(t)		W(t)		W(t)	W(t)				A				W	W		
O/F 011	M		M	M				M	M																													
O/F 072	M	M	M					M(C)	M(C)			Q							S(d)	S(d)	Q(d)	S(d)		Q(d)	S(d)	S(d)	S(d)											
O/F 094	M	M	M	M							M										S(d)	S(d)	S(d)	S(d)	S(d)	S(d)	S(d)											
5 Outfalls		M	M				M																															
O/F 100		2/M	2/M		M			2/M	2/M		M	M	M								Q(d)	Q(d)	Q(d)	Q(d)	Q(d)	Q(d)	Q(d)											
O/F 101	S		S		S			S	S		S																											
O/F 040	M	M	M					M	M		M									Q(d)	M(d)	Q(d)		Q(d)		Q(d)	Q(d)											
O/F 082	M	M	M	M																																		
O/F 056	W	W	W				M(C)		W	W	M		M			M					M(d)	M(d)				M(d)	M(d)											
O/F 080	M	M	M	M	M														S(d)	S(d)	Q(d)	S(d)		S(d)		S(d)	S(d)											
Pearl Harbor																																						
-Drydocks		M			M		M	M	M		M	M	M	M	M	M					M(t)	M(t)	M(t)				M(t)	M(t)	M(t)							M(W)		
-DCUs	C		M													M																						

Table Contents

d=Disolved Metals t=Total Recoverable Metals
C=Continuous D=Daily W=Weekly M=Monthly
Q=Quarterly S=Semiannual A=Annual
3/W=Sampled 3 times per week
2/M=Sampled 2 times per month
A/5=Sampled 5 times per year
IR=Data used from IR Program

Column and Row Headings

F=Flow T=Temperature FC=Fecal Coliform S=Solids Tu=Turbidity DO=Dissolved Oxygen BOD=Biochemical Oxygen Dema
COD=Chemical Oxygen Demand TOC=Total Organic Carbon O/G=Oil & Grease P=Phosphorous TN=Total Nitrogen
NOx=Nitrate/Nitrite NH3=Ammonia Cl=Chlorine As=Arsenic Cd=Cadmium Cr=Chromium Cu=Copper
Pb=Lead Hg=Mercury Ni=Nickel Se=Selenium Ag=Silver Zn=Zinc Fe=Iron Sn=Tin Pes=28 Selected Pesticides
TTO=Total Toxic Organics PAH=Polycyclic Aromatic Hydrocarbon PCB=Polychlorinated biphenyls CN=Cyanide TOX=Toxicit
Bio=Bioaccumulation Sed=Pollutants in Sediment O/F=Outfall # DCU=Dockside Chlorinated Unit TBT=Tributyltin
IWTP=Industrial Waste Treatment Plant MBAS= Methylene Blue-Active Substances
(w)=Whole Effluent Toxicity [wet] Bio=Bioaccumulation TBT=Tributyltin C=Continuc

More Stringent Limitations

In addition to the increased number of parameters required by new NPDES permits, there has been a trend toward more stringent discharge limits. This ratcheting-down of limits evolved from broadly missing the original goal of the Clean Water Act (CWA) to achieve zero discharge of pollutants by 1985, and the regulatory shift from technology-based effluent limits to more protective water quality-based standards (Arbuckle et al., 1991). The following statement from a draft EPA briefing book on trace metal monitoring best exemplifies the situation:

> "increased emphasis on a water quality-based approach to the control of toxic pollutants has necessitated the measurement of metals at water quality criteria levels . . . [these] levels are as much as 280 times lower than those levels required by technology-based controls or obtainable by routine analyses in environmental laboratories" (USEPA, 1994a).

The NPDES limits at LBNSY, PHNSY, and NNSY were taken directly from the States' water quality standards. Only PSNSY's permit writers considered ambient pollutant concentrations in deriving limits from the State standards. These four shipyards all have metal limits in the parts per billion range (figure 8). Based on discussions with shipyard environmental managers, compliance with these low limits has become difficult and practicably unachievable. Even as the shipyards carry out the latest Best Management Practices (BMPs), they frequently exceed the limits of their NPDES permits. Consequently, the yards are turning to processing systems for segregation and treatment of dry-dock wastewater before its discharge into adjacent water bodies.

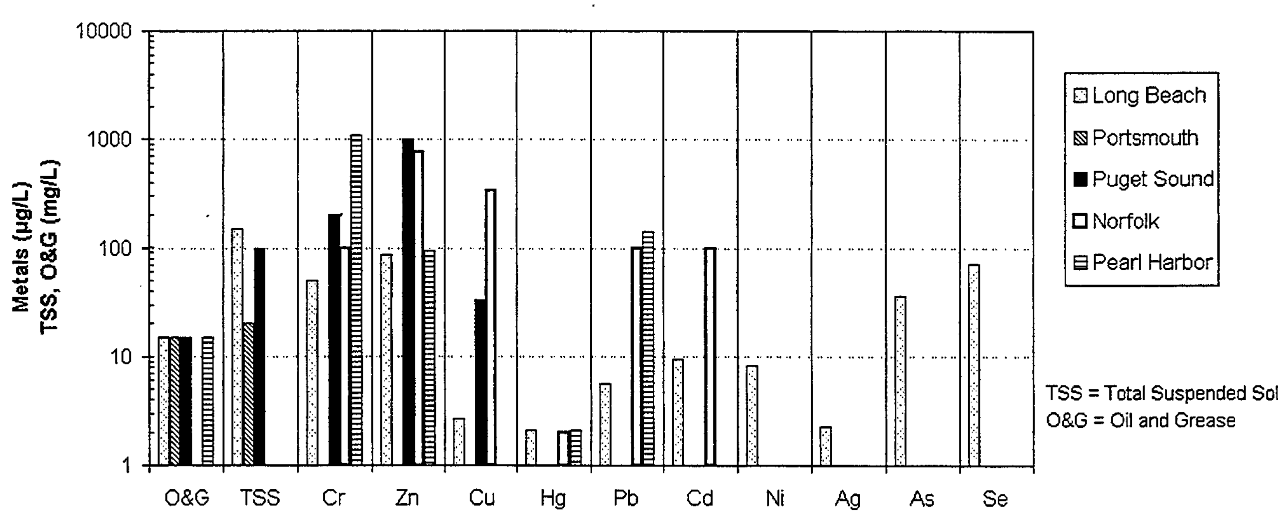

Figure 8. Range of common NPDES limitations.

Mixing and Transport Models

Many biological, chemical, and physical processes affect the dispersal and fate of contaminants released into aquatic environments. These processes include tidal and wind-driven currents, turbulent mixing, volatilization, complexation, sedimentation and resuspension, sorption and desorption, bioaccumulation, bioturbation, biodegradation, photodegradation, and natural weathering (Pritchard, 1987). Ultimately, the question is whether contaminants accumulate in the environment and whether this accumulation adversely affects ecological communities there.

There are two potential benefits for the shipyards in answering these questions. First, contaminants discharged into the water body from a particular discharge may not remain in the water column near that discharge, at concentrations capable of causing significant biological or ecological impacts. Second, contaminants may not remain long enough, or in high enough concentration, to cause effects where they are finally deposited.

EPA addressed the first issue, in part, by allowing regulators to allocate mixing zones in NPDES permits. Mixing zones benefit dischargers by defining a perimeter in the receiving waters around the point of effluent discharge, in which acute and/or chronic water quality standards may be exceeded. EPA's intention was to permit dilution factors that would allow discharge limits that are more realistic and more attainable. Their assumption for allowing mixing zones was that "a small area of concentrations in excess of acute and chronic criteria, but below acutely toxic releases, can exist without causing adverse effects to the overall waterbody." Detailed guidance for calculating mixing zones is given in EPA's Technical Support Document (TSD) for Water Quality-based Toxics Control (USEPA, 1991a), but the formulas apply to rivers and streams, not to harbors or estuaries.

Recognizing that hydrodynamic circulation studies are important for calculating accurate mixing zones, EPA gave guidance on conducting dye tracer studies, and on applying several computer models "to determine the aerial extent of mixing in a water body." EPA recognized the need to regulate water quality based on site-specific hydrodynamic conditions when it said that "dynamic models . . . are more accurate data than steady-state models in reflecting or predicting exposure, provided adequate data exist" (USEPA, 1991a). Such tracer studies and hydrodynamic models would also be important in calculating total maximum daily loads (TMDLs) for deriving wasteload (point sources) and load (non-point source) allocations (WLAs/LAs) in accordance with CWA Section 303.D. Many efforts are now underway to develop site-specific models for predicting hydrodynamic circulation in major water bodies in the U.S. Some of these areas include Chesapeake Bay, Puget Sound, Boston Harbor, San Francisco Bay, and San Diego Bay. However, few models have been incorporated into the development of water quality objectives or NPDES permit limits. The Annapolis Detachment, Carterock Division of the Naval Surface Warfare Center (formerly the David Taylor Research Center(DTRC) developed models for 11 navy harbors, but these would have to be refined for water quality use. NRaD used a DTRC model of the Piscataqua River recently in an RCRA-driven ecological risk assessment for PNSY. Although some contaminants might have characteristics that prevent them from behaving like a mass of water, understanding hydrodynamic circulation is a critical first step in estimating contaminant transport and fate in water bodies. The shipyards could validate and refine a specific harbor model through discrete sampling and assessment of available data relating to pollutant levels in effluent discharges and receiving systems (water and sediments), and any associated biological (or ecological) exposure and effects. Factoring in specific environmental processes (such as those mentioned above) that determine the ultimate fate and effects of water pollutants could provide more accurate calculations of TMDLs. Finally, based on the model's predictions, regulatory agencies could adjust WLAs and LAs so that more appropriate effluent limitations could be assigned for NPDES permittees.

In summary, waterbody-specific hydrodynamic models would enable regulators to prescribe more meaningful effluent limits based on more accurate predictions of contaminant exposure to biota and humans. Presently, only PSNSY has an NPDES permit with a mixing zone. However, this mixing zone appeared to be based on rudimentary dilution factors, and was not calculated using hydrodynamic circulation data specific to the Sinclair Inlet or the formulas provided in the TSD.

Site-Specific Criteria

In 1984, EPA issued guidance (EPA-600-3-H4-099) on using three procedures for establishing site-specific water quality criteria by modifying the national WQC:

- The recalculation procedure, which accounts for toxicological differences in the species used in the derivation of the national criterion and the locally available species;
- The indicator species procedure (now called the water-effects ratio [WER]), which accounts for differences between laboratory bioassay water (used to develop national criteria) and site water in the biological availability and/or toxicity of a contaminant;
- The resident species procedure, which attempts to incorporate the first two methods by considering differences in resident species sensitivity and differences between laboratory and site water (USEPA 1994).

Recently, EPA promulgated "Interim Guidance on Determination and Use of Water-Effect Ratios for Metals," which revised the first two methods, but emphasized WER. This document gives detailed instructions to the 14 States that are subject to the National Toxics Rule (NTR) of 1992. These instructions include advice on how to adjust the aquatic life criteria for metals and other toxic compounds to reflect site-specific conditions. While only California and Washington, of the States with naval shipyards, are on the list and must follow NTR; other States can use the same or a similar approach to adjust their own standards. If the Recalculation Procedure and WER Procedure are used, the former must be performed first. Recalculation is not an option for States under NTR.

The WER is achieved by performing standard toxicity bioassays on site water and establishing a ratio between the results for the site water and those obtained by EPA. That ratio can only be used for the specific contaminants that are tested. Although WERs can be less than 1.0, most are expected to be greater than 1.0, and thus may provide some regulatory relief to NPDES permittees (USEPA, 1994c).

Thirty States have developed some site-specific criteria, but most involve only one or two parameters and are specific only to that State, and not to water bodies. Although "other methods" were used in several cases (USEPA, 1995d), EPA states that of the three methods listed above, only Recalculation and WER have been successfully used (USEPA, 1993a). Except for efforts begun to develop criteria for the Elizabeth River (VA) to support regional NPDES permits (including naval facilities), site-specific aquatic life criteria have not been developed or initiated in the shipyard water bodies that NRaD surveyed.

EPA encourages regulators at the regional and local levels to use site-specific information in developing NPDES permits. Knowledgeable permittees are encouraged to work with the regulators to develop a defensible basis for these revised criteria.

Criteria, Methods, and Limits for Trace Metals

Most Federal and State water quality criteria and standards for metals have been expressed in dissolved metal (DM) concentrations. The TMDLs for specific contaminants in specific water bodies

must be expressed in DM to ensure attainment of water quality criteria. NPDES permits, on the other hand, have always specified metal concentration limits as total recoverable metals (TRM). The TRM value is the sum of dissolved, complexed or colloidal, and particulate fractions of the metal in question. Consequently, there has been a need to convert between both the dissolved and the total forms of metal concentrations.

Based on many toxicity test data during recent years, many scientists and regulators believe that the dissolved fraction of metals is more bioavailable to aquatic biota than the particulate fraction (DiToro et al., 1991). There is still some debate on this issue because the underlying experiments were conducted in the laboratory rather than the natural aquatic environment, and there is some evidence that particulate toxicity exists (EPA, 1993b). However, EPA believes the conservative approach it used to determine dissolved metal criteria compensates for the potential of toxicity caused by the particulate fraction. For example, the metals used in the toxicity tests are added as salts to relatively clean water. The metals in these tests are more biologically available than metals in effluents or in ambient waters. Recently, EPA issued new guidance directing the States to establish dissolved metals standards where possible (USEPA, 1994c). In what has become known as the "Prothro memorandum," EPA "strongly encourage[s] the application of dissolved criteria across a watershed or water body, as technically sound and the best use of resources" (USEPA 1993a, 1993b). There is additional evidence indicating that it may primarily be a particular species of the dissolved metal—Cu^{2+} in the case of copper—responsible for eliciting toxicity in aquatic organisms (Valkirs et al., 1994).

While the States are encouraged to establish standards for dissolved metals, NPDES limits may still be expressed in the total recoverable form if a reliable chemical translator is calculated for converting between the two forms. Historically, permit writers have used a default ratio of 1:1 because data has not been available to calculate accurate translation ratios. This was the case with PSNSY's draft permit. However, the default ratio assumes that all the metal measured in a sample is in the dissolved form, and thus bioavailable. In reality, a significant fraction of the metal may be in particulates that are unavailable for biological uptake. Some local regulators are beginning to specify that permittees should measure the DM and TRM fractions. This would enable the collection of data sets for use in calculating more accurate translator ratios.

According to the NPDES regulations, it has always been possible to express metal limits in NPDES permits based on dissolved concentrations (Bureau of National Affairs, 1994). Because particulates can comprise a large fraction of the total metals in dry-dock process water, limits based upon dissolved concentrations would allow more flexibility in naval shipyard operations. The NNSY NPDES permit specifies some metals in the dissolved form and others in both forms. However, the State did not require these measures for at least 3 years to allow for development of the analytical methods.

Sediment Monitoring

Environmental scientists and regulators recognize that aquatic sediments often serve as sinks for accumulating pollutants discharged into the overlying waters. Consequently, the investigation of contaminant loading in sediments is a useful method for detecting chronic water pollution. However, sediment contamination cannot always be linked with an adjacent discharging facility. Aquatic systems with strong currents might transport contaminants over long distances (National Research Council, 1989; USEPA, 1994d).

EPA and some States have initiated efforts to establish sediment quality criteria, but progress varies widely. The State of Washington is the only State agency that has incorporated Sediment

Management Standards into their regulatory programs (State of Washington, 1991). EPA has specified sediment criteria for only three PAHs and two pesticides (USEPA, 1993). EPA is also encouraging States to include sediment monitoring in NPDES permits (USEPA, 1994d). Local and regional regulators are beginning to do so, but the process is slow because of a lack of sediment quality criteria. Consequently, sediment monitoring is not a major focus of the national NPDES program.

Sediment monitoring is required once every 5 years for only a few compounds at LBNSY. The permits for PHNSY, PNSY, and NNSY do not mention sediment monitoring. PSNSY is required to submit sediment data generated for the IR program on an annual basis.

Ecological Significance

Standards based on water quality criteria represented a first step in U.S. water policy to link concentrations of specific pollutants with biological effects they might cause. In a recent guidance document on Biological Criteria, EPA acknowledged that chemically based water quality programs "alone cannot identify or address all surface water pollution problems" (USEPA, 1990). In that same document, EPA gave guidance to the States for developing both narrative and numerical biological criteria. Narrative criteria are subject to interpretation. Numerical criteria could be established from the measurement of a reference aquatic community's structure and function. Some measures in this way might include similarity indices, coefficients of community loss, and comparisons of dominant taxa. Other measures of existing community structure include species richness, the presence or absence of indicator taxa, trophic composition and distribution, species abundance, biomass, and organism condition.

EPA reiterated in its policy memorandum on Biological Assessments and Criteria (USEPA, 1991) that "biological surveys shall be fully integrated with toxicity and chemical-specific assessment methods in State water quality programs." EPA also stated that this policy "is a natural outgrowth of our greater understanding of the range of problems affecting watersheds from toxic chemicals to physical habitat alteration, and reflects the need to consider the whole picture in developing watershed pollution control strategies."

Nationally, States have developed very few biological criteria. EPA has not formalized any further technical guidance for States to follow in this area. Among the shipyards, only LBNSY is required to monitor marine organisms. It is required to measure the concentration of seven metals and four organic compounds in the tissues of mussels, once a year. This is a standard pollution assessment technique for obtaining bioaccumulation data on uncontaminated organisms. Nationwide, EPA is implementing the Whole Effluent Toxicity (WET) program, which currently affects at least four of the five shipyards surveyed (table 2).

A problem that underlies the WET tests is their lack of relevancy to broader ecological conditions. A failed bioassay on a few species under laboratory conditions does not mean that an ecosystem will be adversely affected. Slooff (1983) reviewed many studies from the early 1980s and showed that for 25 to 30% of chemicals tested, a standard suite of three species (algae, crustacean, and fish) "failed to cover the toxicity level for other aquatic species within one order of magnitude." He also noted "[test] protocols are subject to criticism . . . since ecosystem complexity cannot be deduced from simple toxicity tests . . . [and] ecosystem function may be impaired without killing organisms. Similarly, natural ecosystems may have so much functional redundancy that the disappearance of certain species may not result in deleterious effects on function." Moreover, toxicities may be non-additive when chemicals are mixed together, as is typical of most environments under human

influence. Toxicity tests alone probably cannot accurately predict ecological risk. However, they are probably better at integrating the effects of multiple contaminants than individual water quality criteria.

Standard Analytical Methods

The absence of standard EPA techniques for analyzing metals at trace levels hinders the measurement of the dissolved metal fractions. EPA notes that of the 13 commonly measured metals, seven do not have EPA-approved methods for measuring concentrations down to the levels of water quality criteria (USEPA, 1994a): arsenic, chromium (III), lead, mercury, selenium, silver, and thallium. EPA is developing guidance for using "clean" and "ultra-clean" techniques to make accurate measurements of metals at the parts per billion and trillion levels. Few commercial laboratories can measure metals at these levels, although a number of research laboratories have developed the capabilities. The shipyards' analytical laboratories are currently working to meet these new requirements (section 10). Standard methods for measuring metals at trace levels will make the analysis of the dissolved fraction, which is more bioavailable, more accurate and reliable. They will also help to establish a valid data set for calculating chemical translator ratios to convert between DM and TRM. Most importantly, development of these methods will generate a better baseline data set for assessing background levels.

Table 2. Whole Effluent Toxicity (WET) monitoring.

Shipyards	Type of Test	Species	Periodicity	Endpoints/Pass Criteria	Guidance Document
LONG BEACH	Acute	Fathead minnow (Pimephales promelas)	Quarterly Grab	> 90% survival average of 3	EPA-600-4-85-013
		3-spine stickleback (Gasterosteus) aculeatus		tests - no singular test < 70%	
		(alternative for high salinity)			
PORTSMOUTH	Acute/Chronic	Silverside minnow (Menidia berrylina)	Annual Grab	survival/growth of larvae	(Acute/Chronic refs below)
(Proposed program-	Acute	Mysid shrimp (Mysidopsis bahia)		survival	EPA-600-4-87-027
shipyard presently	Chronic	Sea Urchin (Arbacia punctulata)		fertilization	EPA-600-4-90-028
exempt)		waterflea (Ceriodaphnia dubia) (freshwater)		reproduction & survival	EPA-500-2-90-001
		trout or fathead minnow (freshwater)		survival & growth	
PUGET SOUND	Acute	Silverside minnow or	Quarterly 24 hr composite	No pass/fail criteria given	EPA-600-4-90-027
		Mysid shrimp			
	Chronic	Sand Dollar (Dendraster excentricus),	Quarterly 24 hr composite		EPA-600-4-87-028
		Sea Urchins (Strongylocentrotus droehbachiensis			Dinnel et al. 1987, or
		Strongylocentrotus purpuratus,			FRI-UW-8306 (echinoderm)
		Strongylocentrotus franciscanus)			EPA Region 10 Guidance on
		Pacific Oyster (Crassostrea gigas),			toxicity tests using Urchins
		or Bay Mussel (Mytilus edulis)			& Sand Dollars
					ASTM-E724-89 (bivalve)
NORFOLK			All samples 24-hr composites:		
	Acute	Sheepshead minnow (Cyprinodon variegatus)	Annual on Outfalls 082, 100, 200,	50% survival in 100% effluent	(No references given
			300, 400	in 75% of tests	Test protocols submitted by
		Mysid shrimp	Annual on Outfalls 056, 072, 080,		shipyard for approval by regulators)
			094, 500		
		Mysid shrimp, Sheepshead minnow	Semiannual on		
			Outfalls 011, 034, 044, 100		
			Quarterly (dry weather), Semiannual		
			(wet weather) on Outfalls 015, 017,		
			032, 040, 043, 073, 081, 093		
			Quarterly on Outfall 401		
	Chronic	Mysid shrimp	Quarterly on Outfalls 100, 056	survival, growth, & fecundity:	NOEC>IWC in 75% of tests
		Sheepshead minnow		survival/growth of larvae:	NOEC= No Observable Effects Conc.
					IWC= Instream Waste Concentration
PEARL HARBOR	Acute	Waterflea (1-24 hrs old) (freshwater)	Monthly 24-hr composite	80% survival in 100% effluent	EPA 600-4-85-013
		fish (1-30 days old):			
		Tilapia (Tilapia mossambica)			
		Dolphin fish (Coryphaena hippurus)			
		Shrimp (0-14 days post larval):			
		prawn (Penaeus vannamei)			
		Tiger prawn (Penaeus monodon)			

ANALYSIS OF NPDES PROGRAMS

Compliance with NPDES Permits and Effluent Limits

Despite the naval shipyards' ongoing efforts to achieve marine environmental compliance, they are experiencing some difficulty meeting NPDES permit limits. Recently, PSNSY was sued by a coalition of environmentalist groups over alleged water quality and NPDES violations. In settlement of the lawsuit, the shipyard agreed to complete the $7 million restoration to its sanitary sewer line connected to the Bremerton POTW. Additionally, the shipyard agreed to supply NPDES and spill documentation provided to the EPA or State regulatory authority, and to achieve "substantial" compliance for zinc and oil & grease. After the lawsuit and issuance of the new permit, the shipyard repeatedly exceeded the newly imposed "interim" limits of 70-ppb (daily maximum) and 45-ppb (monthly average) total recoverable copper. Compliance will be more difficult when the regulators enforce the final limits of 33 and 19 ppb. Norfolk has exceeded pH limits at the IWTP and copper and zinc limits at the dry-docks. It received Notice of Violations (NOVs) from the State and was directed to perform a Toxicity Reduction Evaluation (TRE) when it also failed the effluent bioassays test. The Pearl Harbor Shipyard has exceeded the nutrient limits of their permit virtually every month. The Long Beach Naval Shipyard reported no violations of its permit limits, but is capturing 100% of the dry-dock process water. Portsmouth Naval Shipyard has a relatively lenient permit and it has not had any recent problems with NPDES compliance, although it had previous excursions above pH and TSS permit limitations.

If future changes in regulation remove sovereign immunity for CWA as was done for CERCLA and RCRA, NOVs and TREs could result in fines or perhaps litigation. To make matters worse, current trends suggest there will be more parameters to monitor and lower discharge limits when the shipyards' permits are renewed.

Puget Sound. Now that the lawsuit is settled, NPDES copper limits are the major marine environmental compliance concern for PSNSY. The shipyard exceeded the new interim limits for copper soon after they became effective (May 1994). A single 220-ppb (TRM) daily maximum value resulted in a monthly average of 72 ppb. After that, the shipyard exceeded the daily maximum value for copper 8 times in 44 weekly measurements. A reading of 680 ppb was high enough to exceed the monthly limit with an average of 224 ppb. Three other violations occurred during April 1995, exceeding the monthly limit with an average of 105 ppb. A fifth instance of 490 ppb would have also violated the monthly average. However, the NPDES "upset procedures"[5] allowed the shipyard to exclude this value because it was anticipated from maintenance operations.

The shipyard initiated its own study to examine the problem after the first violation under the new permit. The study included leach rate tests from various copper-contaminated materials and sediments. The shipyard also evaluated the effectiveness of its BMPs within the dry-docks. The shipyard found that much copper-containing debris remains after a sweepdown (see Current Strategies to Minimize Pollutants section below). The shipyard believes the predominant sources of copper are copper-containing sediments in the drainage tunnels from residues built up over time, metal cutting operations, anti-fouling paints, and copper slag used in sandblasting media (of which

[5] The NPDES upset procedure involves reporting of an uncontrollable or necessary "non-compliance" before its occurrence.

2% is actually copper). However, the shipyard also estimates it costs $30,000 per day to manually sweep down the dry-docks between shifts.

Norfolk. The shipyard violated the limits for copper and zinc discharged from the dry-docks (335 ppb and 765 ppb, respectively) under the permit that just expired (November 1994). The IWTP also exceeded the limits for pH. The shipyard reported these violations on its Discharge Monitoring Reports (DMRs), and NOVs were later issued by the state. NNSY has also been directed to conduct a TRE because an EPA/state audit discovered the shipyard had failed bioassay results of IWTP effluent. The shipyard recently completed the TRE and found no further toxicity from the effluent bioassays. Shipyard personnel believe that the overuse of a chemical ($KMnO_4$) in the treatment process was the source of the high manganese readings and the cause of the toxicity discovered during the audit.

Pearl Harbor. PHNSY routinely exceeds the limits for nutrients in its permit—mostly for nitrogen, occasionally for phosphorous. The shipyard has reported these monthly violations in its monthly DMRs, but the State has not issued any NOVs. The shipyard has also exceeded the zinc and lead limits of its permit in several instances during the past year. Shipyard personnel believe that anodes attached to the inside of the dry-dock caissons and the hulls of ships are a possible source of the zinc contamination. The current detection limit, however, is only about 100 ppb, so they might be missing problems that may be exacerbated if the next permit specifies techniques with lower detection limits (as has already occurred in California).

The State of Hawaii required PHNSY to investigate its problem with high nutrients in the dry-dock discharges. In its analysis, the shipyard argued that the source of the high levels of nitrogen (both total nitrogen [Total N] and nitrate/nitrite nitrogen [NO^{3-}/NO^{2-}]) was probably organisms decaying in the dry-dock pumps and sumps before entering the groundwater. In its permit renewal application, the shipyard requested that the nutrient requirements be deleted because corrosion inhibitors, formerly a known source of nitrogen for the dry-docks, are no longer used. A possible source for the nitrate/nitrite nitrogen is agricultural and other runoff containing fertilizers. The shipyard found high levels of this form of nitrogen in their groundwater seepage samples.

Long Beach. Shipyard personnel state they have no problems meeting the requirements of LBNSY's current NPDES permit. This is because the shipyard collects 100% of the process water from dry-dock operations and treats the water as necessary. The only types of wastewater discharged from the outfalls are cooling, condensate, and groundwater. However, the shipyard's DMRs show that zinc frequently has been close to the daily limits of 86 to 95 ppb. This is without inclusion of dry-dock water. Zinc was not detected in some previous DMRs, but those analyses had detection limits of only 500 ppb. The shipyard noted in one monthly report that the high zinc concentrations might be attributable to zinc in piping fixtures that convey cooling water discharges.

Current Strategies to Minimize Pollutants

In general, the waste streams discharged through NPDES outfalls are similar among the shipyards because the shipyards are engaged in the same basic industrial processes. One example is the copper from hull coatings, common to all shipyards. There are some differences between the production lines at the shipyards and among their respective throughput volumes. For example, PSNSY is a major site for recycling decommissioned submarines while the work at LBNSY has been general overhaul and repair of ships and submarines. Norfolk and Puget Sound employ 8000 and 10,000 employees, respectively, while the other shipyards employ less than 5000.

The naval shipyards have established a proactive approach to the more-stringent NPDES regulations. Their approaches range from procedural changes such as BMPs to engineering solutions such as segregating water and waste streams in the dry-dock to advanced technologies for the treatment of effluents.

Best Management Practices. The regulators require all of the shipyards to prepare a list of the BMPs they use to prevent water pollution from point and non-point sources. These BMPs can be found in the NPDES permit. Although this is not an area of MESO expertise, the shipyards appear to have adequate BMPs for preventing water pollution at their facilities. A few of the more important practices are as follows:

- Placing temporary barriers between heavy industrial work and the drains to the sump;
- Methodically cleaning the dry-dock floor thoroughly between shifts, or after heavy work, and before water contacts the floor;
- Using special curtains and other barriers to prevent overspray and paint chips from falling to the floor.

BMPs alone cannot solve all the problems of pollution prevention. For example, PSNSY recently vacuumed the dust in a 4- x 4-meter area on a dry-dock floor after a sweepdown. It recovered one-half pound of dust that contained 2% copper. This equates to 43 pounds of copper for the entire dry-dock. However, vacuuming the entire dry-dock after each shift is economically impractical.

Dry-Dock Design: Segregation of Polluted from Clean Water. The five shipyards either have installed, or are planning to install, modifications to dry-dock drainage systems that separate pollutants from clean water. The goal is to discharge only clean water from the dry-docks into the harbor or river, and collect contaminated water for further processing. These modifications typically consist of the following structural changes:

- Filling in lateral drains to make cleaning easier.
- Blocking normal drain paths to direct process water into separate collection sumps (other than those that discharge to the adjacent water body) where the water can be sampled and then sent to the sanitary sewer, or treated, if necessary.

Treatment of NPDES Effluents. Treatment might be the only means to comply with stringent water quality limits in some situations. Currently, LBNSY collects 100% of the process, bilge, and ballast water from the dry-docks and transfers it to temporary storage in transportable Baker Tanks. Shipyard personnel sample the water in these pierside tanks and analyze it to determine if it is suitable for discharge to the sanitary sewer. If it is not suitable, it is sent to the shipyard's IWTP for pre-treatment. Norfolk, on the other hand, has initiated a pilot study to determine the feasibility and cost-effectiveness of treating dry-dock process water at a pierside processing system. One problem with this approach is treating the tremendous volumes of water collected when it rains during heavy industrial operations. These volumes of water push systems to their limits and are very expensive. The long-term plan for PSNSY is to treat or sewer process water once drain modifications are made. Treatment may become practical if the shipyard can segregate its wastewater from the large volume of "clean" intrusion water, including both ground and surface waters (shipyards also use the term seepage or in-leakage). Other shipyards might have to treat dry-dock effluents if their NPDES permit limits are still unachievable after structural modifications are completed.

The following discussion explains the specific strategies used at each shipyard to reduce discharge of contaminated effluents.

Long Beach. The BMPs used at LBNSY are typical of all the shipyards for routine and systematic cleaning of the dry-dock. The shipyard captures 100% of the rainwater and process water entering each dry-dock behind the caisson (dry-dock gate). Lateral drain channels were filled to provide a smooth dry dock floor that facilitates cleaning between work shifts. Rainwater and process water flows down channels on each side of the dock floor to a sump. Water collects in the sump at the low point of the dry-dock and is pumped automatically into one of three 20,000-gallon Baker tanks. Based on the results of analytical tests performed by the shipyard, the water is either sent into the sewer system for processing by the municipal POTW, further treated by the shipyard (if necessary), or disposed of as hazardous waste if not treatable. Grey water from docked ships is sent directly to the sewer whereas bilge and ballast water is pumped to the Baker tanks for testing.

Portsmouth. The shipyard has two instructions on BMPs: Best Management Practices for Shipyard Dry-Docks and Waste Water Disposition, and the Submarine Bilge Water Disposition Instructions. The first is comprehensive, while the latter discusses only waste water generated from dry-dock washdown, temporary cooling, bilge cleaning, hull washing, hydroblasting, and tank/system draining, flushing, and testing. These instructions are very detailed and could be a model for other shipyards.

In dry-dock design, Dry-Dock 2 at PNSY is different from the other two. It has a drain system that can separate intrusion water from the waste process water. The shipyard has not used this system because the current limits can be met through the BMP plan that requires thorough cleaning of the dry-dock floor before releasing any water to the river. All dry-docks appear to have significant amounts of intrusion from the river, especially at high tides. There were no plans to treat any dry-dock wastewater because it was considered unnecessary. This could change with the inclusion of stringent copper or other metal limits in the next permit reauthorization.

Puget Sound. Until dry-dock modifications are completed, the shipyard is ordering vacuum cleaners to make the cleanup efforts more effective and prevent excursions above copper limits. The shipyard is revising an instruction specifically for dry-dock waste management. It has also drafted a BMP Plan (required by the NPDES permit) covering all aspects of shipyard operations. The BMP Plan is modeled after the Washington State Department of Ecology's BMP guidance document for shipyards. The shipyard also issues a specific Environmental Compliance Plan for each ship coming into dry-dock for overhaul (effective until the overhaul is completed).

Although the dry-docks are of different designs, all have some type of longitudinal and lateral drains with no segregation of the water. As a long-term solution to the copper problem, PSNSY is planning to fill in the dry-dock lateral drains (as was done at LBNSY) and add sumps at the low ends. These modifications will make it easier to collect and separate process water and rainwater from groundwater and surface water intrusion. There is a great amount of intrusion from groundwater and rainwater, about 7 million gallons per day (mgd). Most of this is groundwater; the rest is surface intrusion from Sinclair Inlet. The intrusion water was tested and was below the NPDES limits. Rainfall in the region is frequent and often continuous, but usually characterized as misty. Shipyard personnel are investigating the possibility of modifying the "first flush" approach used in Stormwater programs (section 5). In short, the first 0.1 inch of rain is commonly believed to be the most contaminated fraction. Once segregation is established by the modified drainage system, shipyard personnel believe they can solve the copper problem by treating the dry-dock process water produced by freshwater washdowns (before undocking) or the first flush of contaminated water (after a

rainfall). The intrusion water would be discharged directly into the inlet; the contaminated water could go into the sanitary sewer system (if it meets criteria) or sent off-site for further processing (e.g., treatment).

Norfolk. The State of Virginia prescribes the shipyard's BMPs in the permit. The BMP Management Office is responsible for shipboard environmental monitoring, safety, and environmental health problems relating to dry-docked ships. This office is responsible for the procedures related to docking and undocking, loading and unloading, and repairing ships. The work tasks include inspections, implementation of dry-dock BMPs, troubleshooting, and addressing any other issues that might arise. It is working on a standard operating procedure (SOP) for ship repairs. Each class of ship will be assigned a set of procedures that it must follow. Rather than develop a new plan for each ship, NNSY is automating (through computer) these procedures and adapting them as necessary for the dry-docked ships. Shipyard personnel believe this will help reduce costs significantly.

Only Dry-Dock 8 has a water separation scheme at NNSY. This is a pilot project established in anticipation of more stringent limits. Dry-Dock 8 is the largest dry-dock at the shipyard. It can accommodate nuclear-powered aircraft carriers. The shipyard has modified the drainage systems to prevent the dry-dock and process waters from entering the center drains that collect intrusion groundwater. A doghouse-type structure was built on top of these center drains to collect process water and prevent it from entering them. Ship drainage (non-contact cooling water) and intrusion groundwater is directed into the sidewall sumps where pumps lift it up and out of the dry-dock and into the river. The process water collected in the separation scheme is sent to a collection barge and then through a pierside processing system. This system includes a cyclone separator, percolation tank, and dissolved air flotation (DAF) system. The POTW receives the treated water, separates oil and waste, and transfers them to a barge for removal by contractors. When it rains, a large volume of water must be collected and treated, pushing the system to its limits. The shipyard should investigate the standard stormwater approach of collecting only the first flush of rain.

Pearl Harbor. The Water Pollution Control Plan required by the NPDES Permit was published as a shipyard instruction (5090.5 dated 12 Sep 1995). The shipyard also has a BMP Plan that explains housekeeping rules in simple terms to the shipyard workers and ship crews. The BMPs used in Dry-Dock 1 consisted of sponge material and rubber mats laid on top of drain slots to keep debris on the dry-dock floor from entering the drain system while hull work is in progress. This dry-dock receives substantial runoff from surrounding surfaces and buildings because it is the lowest point in the area.

Dry-Dock 1 is undergoing major renovation and will be out of commission for 6 to 9 months in 1996. Port and starboard drains will be added, as will new cross drains. Once the modifications are complete, the shipyard expects to be able to prevent process water from automatically discharging to the harbor (the other dry-docks already have this capability). The staff is also looking at designs that would segregate process water from the large volume of clean ground-water intruding into the side drains. Eventually, they will also need to address collection of the first flush of contaminated water during rainstorms.

Requirements and Conditions of Shipyard Permits

Table 3 provides an overview of monitoring requirements and sampling frequencies at the five naval shipyards. Tables 3 through 7 provide specific information NPDES permit requirements, conditions, and limits for each shipyard. Appendix B contains diagrams of each shipyard that include the location of outfalls.

Long Beach. The NPDES permit for LBNSY is relatively new (July 1993), and it is effective until 1998. The State of California issued the permit after it established the Enclosed Bays and Estuaries Plan (1991). The State Water Resources Control Board rescinded this plan in 1994, following a legal challenge. The California State Supreme Court subsequently ruled that the plan was invalid. Nonetheless, the LBNSY permit contains requirements derived solely from the invalidated plan.

Another problem with LBNSY's permit is that it does not include the Fact Sheet that accompanies NPDES permits. The Fact Sheet provides the background, basis, and assumptions for all monitoring requirements, and the derivations for all limits imposed by the permit. All of the other shipyards have this Fact Sheet attached to their permit. The shipyard's regulatory agency (Los Angeles Regional Water Quality Control Board) stated that the Fact Sheet is for the regulator's use only and is not routinely given to the permittee.

The LBNSY permit includes seven outfalls. All discharge directly into the Long Beach Harbor. Four outfalls release seawater cooling water while the other three discharge cooling water, dry-dock groundwater drainage, and caisson seawater leakage. Because the permit prescribes limits in concentration and mass (table 3), the shipyard has less flexibility in altering operations while still meeting effluent limits.

As table 3 shows, the shipyard must monitor 28 organic compounds. These compounds are unlikely to be present in the shipyard's dry-dock outfalls. The permit writer from the California Regional Water Quality Control Board (Los Angeles) advised the MESO staff that pesticides, PCBs, and other organic compounds have been found in high concentrations in the sediments of Los Angeles and Long Beach Harbors. However, the most recent analysis (annual monitoring reported in DMR) of the sediments adjacent to the shipyard did not detect organochlorine pesticides or PCBs above detection limits ranging from 50 to 150 ppb. In addition, the limits under the 30-day average category in the LBNSY permit were taken directly from the Bays and Estuaries Plan for 24 of the 32 marine aquatic life toxicants (metals and organic compounds). There are no corresponding limits under EPA's criteria.

Table 3. NPDES monitoring requirements for Long Beach Naval Shipyard.

Contaminants	Units	Inst. Max	Daily Max	Daily Avg	Monthly Avg	Frequency & Sample Type
Long Beach Dry-Dock Drainage, Cooling Water, Groundwater/Seawater Seepage, Caisson Leakage						
Temperature	°F					M-G
Flow	MGD					M-G
Residual Chlorine	mg/L		0.1			M-G
Turbidity	TU		75		50	M-G
Oil & Grease	mg/L lbs/d		15 776		10 517	M-G
TSS	mg/L lbs/d		150 7,756		50 2,585	M-G
Arsenic	µg/L lbs/d	69		36 1.86		S-G

Table 3. NPDES monitoring requirements for Long Beach Naval Shipyard. (continued)

Contaminants	Units	Inst. Max	Daily Max	Daily Avg	Monthly Avg	Frequency & Sample Type
Cadmium	µg/L lbs/d	43		9.3 0.48		S-G
Chromium (VI)	µg/L lbs/d	1100		50 2.60		S-G
Copper	µg/L lbs/d	2.7				S-G
Lead	µg/L lbs/d	140		5.6 0.29		S-G
Mercury	ng/L lbs/d				25 0.0012	S-G
Nickel	µg/L lbs/d	75		8.3 0.43		S-G
Selenium	µg/L lbs/d	300		71 3.67		S-G
Silver	µg/L lbs/d	2.3				S-G
Zinc	µg/L lbs/d	95		86 4.50		M-G
DDT	pg/L lbs/d			1,000 0.00005	600 0.00003	A5-G
Dieldrin	pg/L lbs/d			1,900 0.000098	140 0.0000073	A5-G
Endosulfan	ng/L lbs/d	34		8.7 .00045		A5-G
Endrin	ng/L lbs/d	37		2.3 0.000119		A5-G
Heptachlor	ng/L lbs/d			3.6 0.00018	0.17 0.000088	A5-G
Hexachloro-cyclohexane Gamma	ng/L lbs/d			160 0.0082	62 0.0032	A5-G
PCBs	pg/L lbs/d			30,000 0.0016	70 0.0000036	A5-G
Pentachloro-phenol	µg/L lbs/d	13		7.9 0.41		A5-G
Toxaphene	ng/L lbs/d	210		0.02 0.0000011		A5-G
Chlordane	pg/L lbs/d			4,000 0.00020	81 0.0000042	A5-G
1,2-dichloro-benzene	mg/L				18	A5-G
1,3-dichloro-benzene	mg/L				2,600	A5-G
Fluoranthene	mg/L				42	A5-G

Table 3. NPDES monitoring requirements for Long Beach Naval Shipyard. (continued)

Contaminants	Units	Inst. Max	Daily Max	Daily Avg	Monthly Avg	Frequency & Sample Type
Toluene	mg/L				300	A5-G
Tributyltin	ng/L				5.0	A-G
Aldrin	pg/L				140	A5-G
Benzene	mg/L				21	A5-G
Chloroform	mg/L				480	A5-G
Dichloro-methane	mg/L				1,600	A5-G
1,4-dichloro-benzene	• g/L				64	A5-G
Halomethanes	mg/L				480	A5-G
Heptachlor-epoxide	ng/L				0.07	A5-G
Hexachloro-benzene	pg/L				690	A5-G
Alpha Hexachloro-cyclohexane	ng/L				13	A5-G
Beta Hexachloro-cyclohexane	ng/L				46	A5-G
PAHs	ng/L				31	A5-G
2,4,6-trichloro-phenol	mg/L				1.0	A5-G
Whole Effluent Toxicity	% Survival					90% average of 3 tests Q-G

There are other troubling aspects of LBNSY's permit requirements. First, there are the effluent limits themselves. Many effluent limits are in parts per trillion or parts per quadrillion. Some limits are lower than the limits of detection for standard EPA analytical methods. Specifically, EPA standard methods cannot reliably detect mercury, PCBs, dioxin, chlordane, dieldrin, endrin, endosulfan, DDT, toxaphene, heptachlor, and heptachlor epoxide at the levels specified in the LBNSY permit.

Another troubling aspect of the LBNSY permit is the monitoring periodicity. LBNSY is required to monitor these parameters once every 5 years, yet the temporal basis of the limits varies from instantaneous maximums to daily averages to monthly averages. It is unclear what the functional significance would be of a monthly average based on two samples per decade. It is also not clear how

one would compare the single measurement value for a sample taken every 5 years against the three different temporal limits. The same difficulties apply to the instantaneous maximums and daily averages prescribed in the LBNSY permit as limits for the nine metals measured once every 6 months. Finally, samples collected 5 years apart can only be used to estimate (and then, very tentatively) environmental processes with very long time scales (e.g., community succession). There is no indication that the NPDES permit was written to address these long-term processes.

Portsmouth. EPA issued Portsmouth's NPDES permit in October 1992. The State of Maine Department of Environmental Protection (DEP) administers it. The State of New Hampshire has review authority. The permit must meet the more stringent water quality limits of the two States for each parameter. New Hampshire limits are generally more stringent. The permit is due for renewal in 1997.

The shipyard has five permitted discharges (table 4). Three outfalls are from the dry-dock, one is from the power plant, and one is from the tank farm berm. A letter from the shipyard to the State of Maine explained the presence of unpermitted discharges (separate from the dry-docks). The shipyard wanted to clarify the presence of these discharges with the regulators. These discharges include steam condensate, anti-freeze bleedlines, and fuel compensating water that goes through the tank farm OWS. These disclosures will help to avoid any confusion later regarding the characteristics of particular discharges.

Table 4. NPDES monitoring requirements for Portsmouth Naval Shipyard.

Contaminants	Units	Inst. Max	Daily Max	Daily Avg	Monthly Avg	Frequency & Sample Type
Outfalls 001, 002, 003—Dry-Dock Sump Discharges						
Flow	MGD					M-Est
TSS	mg/L		20			M-G
Oil & Grease	mg/L		15			M-G
pH	SU		Min 6.5 - Max 8.0			M-G
Outfall 004—Power Plant Discharge						
Flow	MGD		44		33	IC
TSS	mg/L		25		15	M-G
Oil & Grease	mg/L					M-G
Temp	ºF		85			D-G
Temp. Delta	ºF		35			IC
pH	SU		Min 6.5 - Max 8.0			M-G
Outfall 005—Tank Farm Oil Water Separator						
Flow	MGD					M-Est
TSS	mg/L		20			M-G
Oil & Grease	mg/L		15			M-G
PAHs	g/L					A-G
pH	SU		Min 6.5 - Max 8.0			

Overall, PNSY has the least-restrictive NPDES requirements and conditions of the five shipyards. Its permit requires monitoring of flow, total suspended solids, oil and grease, temperature, and pH, with limits on the last four. The permit does not require monitoring of metals or the analysis of contaminants in sediments. It does require monitoring of PAHs at the tank farm OWS, but it imposes no limit on PAHs. There has been little regulatory oversight of the NPDES program at PNSY because the permit is simple and there have been no recent violations. Despite this history, a change of regulatory personnel or policy could quickly change oversight of the PNSY permit. The shipyard staff is concerned about receiving considerably more-stringent limits when their permit is renewed in 2 years.

The State of Maine proposed changes to the NPDES program that introduce a new WET testing program for all POTWs and industrial process waste dischargers. Shipyard personnel received written notification in 1995 (State of Maine, 1995) that they would not have to implement the WET program because the shipyard "does not discharge process waste water as defined by the NPDES program." This makes PNSY the only shipyard without toxicity requirements. However, this might be a disadvantage in the long term, because the shipyard will have no information that relates effluent discharges to any integrative measures of biological effects because of multiple contaminants in effluents.

If the regulators reverse their decision and require PNSY to implement the WET program, the shipyard would have to do so before submitting a renewal application for its next NPDES permit. Since the current permit expires in 1997, testing would have to begin sometime in 1996. The draft SWTCP guidance is more detailed than the toxicity programs at the other four shipyards. Portsmouth would have a complex testing schedule that prescribes different frequencies for screening and surveillance tests done under the WET and chemical-specific testing. Whereas WET tests the effects of multiple contaminants in an effluent sample, chemical-specific testing analyzes the effects of certain priority pollutants present in a permitted discharge. Portsmouth would also have different species assigned to their toxicity test, depending on whether the effluent is being discharged into marine or fresh waters.

Puget Sound. The NPDES permit for PSNSY became effective in April 1994 and expires in 1999. EPA is the lead agency for federal facilities in the State of Washington (the State Department of Ecology is the lead agency for all other permittees). The permit includes three sets of monitoring requirements, corresponding to three different groups of outfalls:

- Outfalls 018, 018A, and 096 discharge dry-dock drainage (including ground and marine intrusion), non-contact cooling water, and stormwater from dry-docks 1 through 5;

- Outfall 019 discharges the same from Dry-Dock 6;

- Outfall 021 discharges wastewaters from the power plant.

PSNSY is an example of how a permitted activity can negotiate during the renewal process to obtain site-specific criteria. In particular, the dissolved copper levels in Sinclair Inlet were greater than the water quality standard. They were also higher than the limits in the shipyard's draft permit. The initial daily maximum and monthly average effluent limits for copper were set at 6 and 3 ppb TRM, respectively. EPA Region 10 regulators used the default DM:TRM ratio of 1:1 to arrive at these limits because seasonal data for calculating a good translator ratio were not available. This conservative approach made the permit more restrictive because the shipyard has a greater problem

with particulate copper. Ambient monitoring demonstrated that the background levels were closer to 6 ppb for dissolved and 22 ppb for total recoverable copper in the Sinclair Inlet. Thus, the proposed limit was lower than ambient copper levels. It was also below the detection limit for the prescribed analytical methods. PSNSY offered additional data to EPA of the ambient copper concentrations (12 data points), from which a translator ratio of 1:3 (DM:TRM) was obtained. Using this translator, the regulators calculated new daily and monthly limits of 33 and 19 ppb, respectively (table 5). The shipyard also negotiated to phase in the new limits. Until December 1996, the interim limits will be 70 ppb (daily) and 45 ppb (monthly).

Despite these negotiations, the shipyard has been unable to consistently meet the interim limits. It will have greater problems meeting the final limits. Because most of the copper in the shipyard's discharge effluent is in particulate form, the true DM:TRM ratio may be much greater than 1:3. Additionally, the shipyard's limits are expressed in mass and concentration for some copper, solids, and oil/grease requirements. These limits remove any flexibility the shipyard may have to alter operations as necessary. Puget Sound is the only shipyard that has mixing zones specified in its NPDES permit. At Outfalls 018 and 019, the permit allows a 20-foot acute mixing zone (2:1 dilution) to meet daily limits and a 200-foot chronic mixing zone (4:1 dilution) to achieve monthly limits. At Outfall 021 (the Steam Power Plant), mixing zones of 24-feet (daily limits) and 150-feet (monthly limits) were carried over from the previous permit. A 100:1 diffuser is also used. It is not clear to the shipyard or to MESO how the mixing zones were determined and how they were used to mathematically derive the discharge limits.

Other conditions of the PSNSY permit were also removed or changed because of the shipyard's negotiations with the regulators. The affected conditions include the following:

- Requirements to monitor for lead and zinc were removed from the permit because monitoring results showed that concentrations of these metals were "well below the dissolved criteria and did not represent a reasonable potential to cause violations of water quality standards."

- A 24-hour composite sampling was approved for metals and WET because of the variability of pollutant concentrations throughout the course of a day.

- The requirement to monitor pH at two outfalls was removed because the discharges from those outfalls "are approximately two-thirds seawater which infiltrates into the dry-docks...(and)...it is unlikely that any significant change in pH will occur because of the natural buffering of the marine water."

- Flow limits for the power plant were increased because of operational changes.

- The permit will not require any additional WET testing dilutions if the No Observed Effects Concentration (NOEC) is determined to be 100 percent effluent.

Table 5. NPDES monitoring requirement for Puget Sound Naval Shipyard.

Contaminants	Units	Inst. Max	Daily Max	Daily Avg	Monthly Avg	Frequency & Sample Type
Outfalls 018, 018A, 096—Dry-Dock Drainage and Noncontact Cooling Water						
Flow	MGD					W-Est
Oil & Grease	mg/L			15	10	W-G
Copper	mg/L lbs/d			0.033, .070(I) 0.77	0.019, .045(I) 0.44	W-G, t
Lead	mg/L					M- 24 hr Cp, t
Mercury	mg/L					M- 24 hr Cp, t
Zinc	mg/L					M- 24 hr Cp, t
Copper	mg/L					M- 24 hr Cp, t
Temp.	°F					M-G
PCBs	mg/L					M-G
Whole Effluent Toxicity	% Survival					50% in 100% effluent Q- 24 hr Cp
Outfall 019—Dry-Dock Drainage, Noncontact Cooling Water and Stormwater						
Flow	MGD					W-Est
Oil & Grease	mg/L			15	10	W-G
Copper	mg/L lbs/d			0.033, .070(I) 1.44	0.019, .045(I) 0.83	W-G, t
Lead	mg/L					M- 24 hr Cp, t
Mercury	mg/L					M- 24 hr Cp, t
Zinc	mg/L					M- 24 hr Cp, t
Copper	mg/L					M- 24 hr Cp, t
Temp.	°F					M-G
PCBs	mg/L					M-G
Whole Effluent Toxicity	% Survival					50% in 100% effluent Q- 24 hr Cp

Table 5. NPDES monitoring requirement for Puget Sound Naval Shipyard. (continued)

Contaminants	Units	Inst. Max	Daily Max	Daily Avg	Monthly Avg	Frequency & Sample Type
Outfall 021—Treated Steam Plant Wastewater						
Flow	MGD				0.17	C
Temp.	ºF			90 (Winter) 90 (Summer)	70 (Winter) 75 (Summer)	D-G
Oil & Grease	mg/L lbs/d			15 21.28	10 14.18	D-G
TSS	mg/L lbs/d			100 141	30 42.53	3/W 24 hr Cp
Total Residual Chlorine	mg/L			0.20		2/D G
Free Available Chlorine	mg/L			0.50	0.20	2 per Day G
Chromium	mg/L			0.20	0.20	W-G, t
Zinc	mg/L			1.0	1.0	W-G, t
pH	SU		Min 6.0 - Max 9.0			D-G

The shipyard received a negative response on one request that might be a problem for other shipyards. PSNSY questioned the basis and authority for the permit requirement that discharges of bilge and ballast water from vessels undergoing service within the shipyard be treated for removal of oil and grease. The EPA responded that the basis and authority was derived from 40 CFR 122.44(k) and that the exclusion in CFR 122.3 "does not apply to discharges from vessels undergoing maintenance or repairs within the shipyard because such vessels are not engaged in normal operation."

Norfolk. Norfolk's previous NPDES permit was issued in 1985 and expired in 1990. The State of Virginia Department of Environmental Quality (DEQ) was planning to issue a new permit with stringent limits based on national water quality criteria. They altered this plan because of a lawsuit filed by a consortium of plaintiffs, including the Hampton Roads Sanitation District. There will be no new effluent limits imposed until the legal challenge is resolved. Meanwhile, the renewed permit was finalized on 4 November 1994, with sampling to begin on 1 December 1994. The permit will expire in 1999. NNSY was also involved in negotiating the terms of its permit.

The regulators have classified NNSY's more than 100 outfalls into four groups. Group I consists of nine process wastewater outfalls and includes the four dry-dock outfalls. Group III includes the remaining 10 combined flow outfalls—those that discharge stormwater and some type of dry weather flow. The 95 permitted storm water outfalls are split between Group II (58) and Group IV (37). This section discusses the requirements of the Group I and Group III outfalls; Section 5 (Stormwater) discusses Groups II and IV.

As is evident in table 6, Norfolk has the most complex NPDES permit of any of the shipyards. It includes 30 parameters measured with 12 different monitoring schemes prescribed for the 16 point source outfalls (Group I and III). Of the 200 periodic measurements assigned to all shipyards (table 1), Norfolk is responsible for 131 of these.

Table 6. NPDES monitoring requirements for Norfolk Naval Shipyard.

Contaminants	Units	Inst Max	Daily Max	Daily Avg	Monthly Avg	Frequency & Sample Type
Outfalls 200, 300, 400, and 500—Dry-Docks' Drainage—Group I						
Flow	MGD					M-C
pH	SU		Min 6.0 - Max 9.0			M-G
Total Phosphorus	mg/L			2		M- 24-hr Cp
Total Nitrogen	mg/L					M- 24-hr Cp
Fecal Coliform	N/CML					Q-G

Table 6. NPDES monitoring requirements for Norfolk Naval Shipyard. (continued)

Contaminants	Units	Inst Max	Daily Max	Daily Avg	Monthly Avg	Frequency & Sample Type
Outfalls 200, 300, 400, and 500—Dry-Docks' Drainage—Group I						
TOC	mg/L					Q- 24-hr Cp
Oil & Grease	mg/L					Q-G
TSS	mg/L					Q- 24-hr Cp
Ammonia-Nitrogen	mg/L					Q- 24-hr Cp
Cadmium	µg/L		100			Q- 24-hr Cp, t,d
Chromium	µg/L		100			Q- 24-hr Cp, t
Hexavalent Chromium	µg/L					Q-Cp, d
Copper	µg/L		335			Q- 24-hr Cp, t,d
Lead	µg/L		100			Q- 24-hr Cp t,d
Silver	µg/L					Q-Cp, d
Zinc	µg/L		765			Q- 24-hr Cp, t,d
Total Cyanide	µg/L					S-G
Mercury	µg/L		2			A-G, t
Tributyltin	µg/L					A- 24-hr Cp

Table 6. NPDES monitoring requirements for Norfolk Naval Shipyard. (continued)

Contaminants	Units	Inst Max	Daily Max	Daily Avg	Monthly Avg	Frequency & Sample Type
Outfalls 015, 017, 043, 081, 093—(5 Outfalls) Industrial Drainage - Group I						
Flow	MGD					M-Est
pH	SU		Min 6.0 - Max 9.0			M-G
Temp.	°C					M-IS
Outfall 040—Combined Flows from IWTP 401 & Stormwater from Facility & the City of Portsmouth, VA—Group III						
Flow	MGD					M-Est
pH	SU		Min 6.0 - Max 9.0			M-G
Temp.	°C					M-IS
Oil & Grease	mg/L					M-G
Copper	µg/L					M-G, d
Total Cyanide	µg/L					Q-G
Hexavalent Chromium	µg/L					Q -G, d
Lead	µg/L					Q-G, d
Nickel	µg/L					Q-G, d
Silver	µg/L					Q-G, d
Zinc	µg/L					Q-G, d

Table 6. NPDES monitoring requirements for Norfolk Naval Shipyard. (continued)

Contaminants	Units	Inst Max	Daily Max	Daily Avg	Monthly Avg	Frequency & Sample Type
Outfall 401—Industrial Wastewater Treatment Plant Discharge and Metal Finishing Waste(s)—Group III						
pH	SU		Min 6.0 - Max 9.0			D-G
Temp	°C		35			D-IS
Oil & Grease	mg/L lb/d		52 87		26 43	W-G
Cadmium	μg/L lb/d		690 1.2		260 0.4	W- 24-hr Cp, t
Chromium	μg/L lb/d		2770 4.6		1710 2.9	W- 24-hr Cp, t
Hexavalent Chromium	μg/L lb/d		1000 1.7		50 0.1	W-G, d
Copper	μg/L lb/d		3380 5.6		2070 3.5	W- 24-hr Cp, t
Total Cyanide	μg/L lb/d		1200 2		650 1.1	W-G
Lead	μg/L lb/d		690 1.2		430 0.7	W- 24hr Cp, t
Nickel	μg/L lb/d		3980 6.6		2380 4	W- 24-hr Cp, t
Silver	μg/L lb/d		430 0.7		240 0.4	W- 24-hr Cp, t
Zinc	μg/L lb/d		2610 4.4		1480 2.5	W- 24-hr Cp, t

Table 6. NPDES monitoring requirements for Norfolk Naval Shipyard. (continued)

Contaminants	Units	Inst Max	Daily Max	Daily Avg	Monthly Avg	Frequency & Sample Type
Outfall 401—Industrial Wastewater Treatment Plant Discharge and Metal Finishing Waste(s)—Group III						
TSS	mg/L lb/d		60 100		31 52	W- 24-hr Cp
Total Phosphorus	mg/L					W- 24-hr Cp
Nitrates	mg/L					W 24-hr Cp
MBAS	mg/L					W- 24-hr Cp
TOC	mg/L					M- 24-hr Cp
Whole Effluent Toxicity	% Survival		1		50% in 100% effluent 2 of 8 acute tests NOEC < IWC in 2 of 8 chronic tests	Q- 24-hr Cp
Total Toxic Organics	g/L lb/d		2130 3.6			A-G
Outfall 056—Once-Through Non-Contact Cooling and Stormwater Runoff—Group III						
Flow	MGD					W-Est
pH	SU		Min 6.0 - Max 9.0			W-G
Temp.	°C		43			W-IS
Fecal Coliform	N/CML					M-G
Oil & Grease	mg/L					M-G
COD	mg/L					M-G

Table 6. NPDES monitoring requirements for Norfolk Naval Shipyard. (continued)

Contaminants	Units	Inst Max	Daily Max	Daily Avg	Monthly Avg	Frequency & Sample Type
Outfall 056—Once-Through Non-Contact Cooling and Stormwater Runoff—Group III						
Total Phosphorus	mg/L				2	M-G
Total Nitrogen	µg/L					M-G
Copper	µg/L					M-G, d
Lead	µg/L					M-G, d
Silver	µg/L					M-G, d
Zinc	µg/L					M-G, d
Outfall 072—Industrial Drainage—Group III						
Flow	MGD					M-Est
pH	SU		Min 6.0 - Max 9.0			M-G
Temp.	°C					M-IS
Fecal Coliform	N/CML					M-G
COD	mg/L					M-G
Total Phosphorus	mg/L					Q-G
Copper	µg/L					Q-G, d
Nickel	µg/L					Q-G, d
Cadmium	µg/L					S-G, d
Total Cyanide	µg/L					S-G

Table 6. NPDES monitoring requirements for Norfolk Naval Shipyard. (continued)

Contaminants	Units	Inst Max	Daily Max	Daily Avg	Monthly Avg	Frequency & Sample Type
Outfall 072—Industrial Drainage—Group III						
Hexavalent Chromium	µg/L					S-G, d
Lead	µg/L					S-G, d
Selenium	µg/L					S-G, d
Silver	µg/L					S-G, d
Zinc	µg/L					S-G, d
Outfall 080—Industrial Drainage and Discharge from Hydraulic Test Facility—Group III						
Flow	MGD					M-Est
pH	SU		Min 6.0 - Max 9.0			M-G
Temp.	°C					M-IS
Fecal Coliform	N/CML					M-G
Oil & Grease	mg/L					M-G
Copper	mg/L					Q-G, d
Hexavalent Chromium	µg/L					S-G, d
Cadmium	µg/L					S-G, d
Lead	µg/L					S-G, d
Nickel	µg/L					S-G, d
Silver	µg/L					S-G, d
Zinc	µg/L					S-G, d

Table 6. NPDES monitoring requirements for Norfolk Naval Shipyard. (continued)

Contaminants	Units	Inst Max	Daily Max	Daily Avg	Monthly Avg	Frequency & Sample Type
Outfall 082—Combined Drainage from Naval Shipyard and City of Portsmouth, VA—Group III						
Flow	MGD					M-Est
pH	SU		Min 6.0 - Max 9.0			M-G
Temp.	°C					M-IS
Fecal Coliform	N/CML					M-G
Outfall 094—Industrial Drainage—Group III						
Flow	MGD					M-Est
pH	SU		Min 6.0 - Max 9.0			M-G
Temp.	°C					M-IS
Fecal Coliform	N/CML					M-G
Oil & Grease	mg/L					M-G
Copper	mg/L					S-G, d
Nickel	µg/L					S-G, d
Zinc	µg/L					S-G, d
Cyanide	µg/L					S-G, t
PCBs	µg/L					S-G

Table 6. NPDES monitoring requirements for Norfolk Naval Shipyard. (continued)

Contaminants	Units	Inst Max	Daily Max	Daily Avg	Monthly Avg	Frequency & Sample Type
Outfalls 100-101—Industrial Drainage & Emergency Overflow from Refuse Derived Fuel Steam Generating Facility Ponds & 102—Stormwater from Bermed Potable Water Storage Area—Group III						
Flow	MGD					2/M-Est
pH	SU		Min 6.0 - Max 9.0			2/M-G
Temp.	°C					2/M-IS
Fecal Coliform	N/CML					2/M-G
Oil & Grease	mg/L					M-G
TSS	mg/L					M-G
Total Phosphorus	mg/L				2	M-G
Total Nitrogen	mg/L					M-G
Copper	mg/L					Q-G, d
Nickel	µg/L					Q-G, d
Selenium	µg/L					Q-G, d
Zinc	µg/L					Q-G, d
Outfall 101—Emergency Overflow from Holding Ponds at the Refuse Derived Fuel Facility—Group III						
Flow	MGD					S-Est
pH	SU					Q-G
Temp.	°C					S-IS
Oil & Grease	mg/L					S-G
TSS	mg/L					S-G

The NNSY permit is confusing because the descriptions of the outfall discharges and monitoring requirements are contradictory in the different parts of the permit and the Fact Sheet. These contradictions may require unnecessary monitoring by the shipyard. When the shipyard corresponded with the State to point out these discrepancies, the State regulators responded that they were minor and would not affect the monitoring requirements or limits. Consequently, the permit was issued without correction to the Fact Sheet. The Fact Sheet also states that many outfalls, which convey primarily stormwater, have point-source target parameters because they collect runoff from parts of the shipyard that may be associated with very specific industrial operations. However, EPA has already developed a specific set of stormwater monitoring requirements for the shipyard industry that could be used to replace the complicated scheme with a more representative sampling. See section 5 for further discussion on these new stormwater requirements.

Besides the physical and chemical parameters, the new outfall-specific Toxics Management Program (TMP), which incorporates WET, prescribes a complicated testing program (table 2). The Atlantic Division of NAVFAC is joining with industry to complete a water quality study for the Elizabeth River. The objective of this study is to ensure that the next round of NPDES permits for Norfolk's naval installations will have more relevant requirements and limitations. The study is attempting to establish site-specific information, including a contaminant fate and transport model, chemical translator ratios to convert between dissolved and total recoverable metal measurements, and water-effect ratios.

The State of Virginia is switching its monitoring requirements from TRM to DM. The new requirements to monitor DM will not be mandated until 3 years after the permit is issued. This will allow for the development of appropriate trace metal analytical procedures on a statewide (and arguably nationwide) basis. The permit also says that "[to account for] evolving DEQ and EPA policies and positions...the frequency of [metals] monitoring may be relaxed somewhat."

As table 6 shows, the limits for copper from IWTP outfall at NNSY into the Elizabeth River are about 10 times higher than the copper limits at other outfalls. This disparity exists because the limits for industrial waste treatment facilities are taken directly from the categorical effluent guidelines for that industry. It is unclear how two outfalls in the same ecosystem only a few hundred yards apart can have a tenfold difference in copper limits. The limits for IWTP monitoring are also expressed in mass and concentration, which limit operational flexibility.

The State of Virginia generally allows mixing zones. Because water quality in the Elizabeth River is considered impaired, the NNSY permit does not incorporate dilution into the calculation of discharge limits. This position is inconsistent with the PSNSY permit, which allows mixing zones although Sinclair Inlet does not meet the water quality criterion for copper. Like Puget Sound, the NNSY permit mentions the treatment of contaminated bilge and ballast water and directs the Navy to continue efforts to remove discharges of oily waste water into the Elizabeth River from berthed vessels.

The State of Virginia has directed NNSY to implement 24-hour time-proportioned composite sampling. This means that the shipyard must collect three separate samples automatically, 8 hours apart over a 24-hour period. Because most dry-dock discharges occur when the sump is full and triggers a pump, this requirement cannot easily be met. Norfolk is still communicating with the regulators to explain the mechanics of the situation. Other shipyards may encounter similar problems relating to misunderstandings of shipyard dry-dock operations.

Pearl Harbor. The Pearl Harbor Shipyard has two NPDES permits: one to regulate six outfalls from four dry-docks, and another to regulate nine portable Dock Chlorination Units (DCUs) for Dry-Docks 1, 2, and 4, and Piers B1 to B21. The shipyard submitted its renewal application for the dry-

dock permit well before the expiration date of December 1994. The shipyard has not received a new draft or final permit.

The dry-docks at PHNSY are authorized to discharge wastewater from wet sandblasting, hydroblasting, cooling, dry-dock seepage, and rain runoff. The DCUs are authorized to discharge cooling water from their units.

No harbor mixing models were used to derive the limits, so the limits are primarily the same numbers as the water quality standards (table 7). Mixing zones are allowed in Hawaii, but according to the State regulators, they were not included in the shipyard's permit because its outfalls are above water.

Table 7. NPDES monitoring requirements for Pearl Harbor Naval Shipyard.

Contaminants	Units	Inst. Max	Daily Max	Daily Avg	Monthly Avg	Frequency & Sample Type
Outfalls 001, 002A, 002B, 003, 004A, and 004B						
TSS	mg/L					M-Cp
Settleable Matter	mg/L					M-Cp
Oil & Grease	mg/L		15			M-G
BOD	mg/L					M-Cp
Total Residual Oxidants	µg/L		13.0			M-G
Lead	µg/L		140.0			M-Cp
Zinc	µg/L		94.0			M-Cp
Chromium (VI)	µg/L		1,100.0			
Mercury	µg/L		2.1			M-Cp
Copper	µg/L					M-Cp, t
Iron	µg/L					M-Cp, t
Tin	µg/L					M-Cp
Total Nitrogen	µg/L		300.00			M-G
Ammonia Nitrogen	µg/L		10.00			M-G
Nitrate+Nitrite Nitrogen	µg/L		15.00			M-G

Table 7. NPDES Monitoring Requirements for Pearl Harbor Navl Shipyard. (continued)

Contaminants	Units	Inst. Max	Daily Max	Daily Avg	Monthly Avg	Frequency & Sample Type
Outfalls 001, 002A, 002B, 003, 004A, and 004B						
Total Phosphorus	µg/L		60.00			M-G
Temp.	°C		Ambient +/- 1°C			M-G
pH	SU		Ambient +/- 0.5su, >6.8, <8.8			M-G
Dissolved Oxygen	% Saturation		>60%			M-G
Whole Effluent Toxicity	% Survival					80% Survival in 100% effluent M-Cp

The PHNSY permit has some technical problems. The method prescribed to measure chlorine (TRO) is not applicable to seawater samples. Correspondence was attached to the application for renewal, requesting a method change. In addition, the shipyard believes that no method exists to measure low levels of COD in seawater and they would like this requirement deleted. Discussions with scientists at NRaD support this system. Although not part of the NPDES permit, sediment monitoring has been done because of a chromic acid spill 10 years ago, but the resulting data have not indicated any potential contamination. The shipyard has requested that this requirement be eliminated.

CONCLUSIONS AND RECOMMENDATIONS

NPDES requirements for the naval shipyards are stringent and are becoming more so. Recent limits on effluents are at or near the water quality criteria derived from laboratory bioassays. They are often below ambient water concentrations; some are undetectable using standard EPA analytical methods. All shipyards have had problems with NPDES compliance in the past. Three (Puget Sound, Norfolk, and Pearl Harbor) are still having difficulty complying with provisions of their NPDES permits. The parameters of primary concern are the heavy metals, especially copper, zinc, and lead. The shipyards are working to achieve compliance with these limits through innovative BMPs that reduce the discharge of pollutants and through dry-dock modifications that segregate process waters from clean rain or groundwater.

However, the path to positive marine environmental compliance will be difficult. Even the best BMPs and dry-dock designs will probably not bring the shipyards into compliance with parts per billion, trillion, or quadrillion limits for trace organics and metals. In the short term, strong negotiation by the shipyards may help to remove, reduce, or relax monitoring requirements and effluent limitations. Proactive environmental management to gather additional scientific data for site-

specific criteria will be critical to a strong negotiating position. On a longer time scale, NRaD will work with the shipyards and the applicable regulatory agencies to implement an integrated ecological risk assessment program.

Negotiating with the Regulators

MESO's understanding of the existing regulatory climate comes from our review of available correspondence and discussions with shipyard program managers. Based on this review, regulatory oversight varies from the relatively lenient regulations at Portsmouth and Pearl Harbor to the relatively strict regulations for Long Beach, Norfolk, and Puget Sound. The regulators at both PNSY and PHNSY have been slow to implement new NPDES requirements and to take enforcement actions. Portsmouth may not have to implement proposed toxicity monitoring, and nutrient levels at PHNSY are consistently exceeded (without incurring fines, violation notices, or even warnings). The State of Hawaii recently issued an extension on the permit that expired in December 1994 because they had not completed a draft permit to replace it. Long Beach, on the other hand, is under very stringent regulatory requirements. Its discharge limits are so low, the shipyard is collecting 100% of the dry-dock process water. Specific negative comments regarding Long Beach's compliance status were written into the current permit. Norfolk has the most complex set of monitoring requirements that is affecting their workload. Puget Sound also has a tough compliance profile. Some of its discharge limits are so low they are practically unachievable. The number of civil lawsuits involving water or sediment pollution (e.g., the suit against PSNSY mentioned previously) in the State of Washington has forced regulators to take a stronger role in enforcing environmental regulations.

Despite the differing regulatory climates, the national NPDES program is flexible and many conditions and requirements of NPDES permit can be negotiated. The following quotation explains:

"Many conditions typically included in industrial permits are either negotiable or susceptible to legal attack. Accordingly, proposed permit conditions should be carefully analyzed and, if inappropriate, modified, and if need be, contested." (Arbuckle et al., 1991).

The shipyards are beginning to realize the importance of negotiation and are becoming proactive in seeking more realistic terms for their programs. Puget Sound negotiated the following:

- Limits that were above ambient levels;
- More representative composite sampling;
- Increased flow limits to fit proposed changes in IWTP operations;
- Removal of pH, lead, and zinc monitoring at their dry-docks;
- Removal of some conditional, but excessive, WET testing.

Norfolk negotiated to have some outfalls removed from its monitoring list to reduce the frequency of some monitoring requirements and to remove certain parameters and limitations from the permit.

Refinement of Permits

Shipyards can refine the conditions and requirements of their NPDES Permits to improve compliance. These include the following areas:

Classification of Outfalls and Discharges. Although the industrial operations vary between the shipyards, all have discharges from dry-dock caisson drainage, cooling water, steam condensate, intrusion groundwater and surface water, and stormwater into the surrounding rivers and/or harbors.

The major differences between the shipyards arise from the manner in which these discharges are classified and regulated. As table 1 shows, there is much variability in monitoring requirements from the five permitted outfalls at Puget Sound and Portsmouth to the more than 100 permitted outfalls at Norfolk.

Proper classification of the types of discharges from the outfalls is important because it ensures that more relevant parameters are monitored. It is also important to classify outfalls according to the proper regulatory framework. For example, EPA has already specified in their proposed Multi-Sector Permit for Shipyards and Boatyards which parameters should be monitored at these types of facilities (section 5). Nonetheless, many outfalls at NNSY that appear to convey only stormwater have been assigned monitoring criteria that more closely resemble those for industrial point-source outfalls.

These different monitoring schemes may appear to complicate the shipyard's sampling and analysis efforts. It is, however, as important to know the terrestrial sources and pathways of contaminants originating from the shipyard as it is to know the hydrodynamic transport and fate of pollutants once they enter the aquatic environment (as discussed at the beginning of this section—Mixing and Transport Models). However, additional resources will be required to conduct the difficult task of effluent characterization at the outfalls.

Finally, proper outfall classification helps to identify and subsequently eliminate illicit discharges. Once the entryways to the storm drains and regulated (NPDES point source) discharge drains are located, the intentional or unintentional dumping of industrial wastewater and other liquids can be more easily traced and prevented.

Methods of Representative Sampling. NPDES permits typically specify that water samples must be collected as a singular grab sample or by compositing water collected over a longer period. Composite samples, because they integrate changes in the water composition over time, are more representative of the effluent characteristics. They can also lessen the impact of a singular spike in the concentration of a pollutant resulting from an unusual occurrence in the dry-dock operations. However, composite sampling is not always possible because of the episodic nature of shipyard effluents. Towards this end, the shipyards need to continue to explain the unique characteristics of ship repair operations to NPDES regulators to ensure representative sampling with respect to time.

Representativeness of sampling with respect to space refers to determining the right point along the effluent conveyance from which to draw the NPDES sample. For example, if the sample is taken from a point where there is much sedimentation, analytical results might incorrectly show that the discharge is out of compliance. This concern is especially important for parameters such as metals that bind to particulate matter, turbidity, and total suspended solids.

Periodicity of Monitoring. The sampling frequencies for the shipyards' monitoring programs vary from "continuous" for some conventional parameters, such as flow and temperature, to once every 5 years for the 28 organic compounds in the LBNSY permit. As figure 9 shows, the distribution of sampling periodicities is normal about monthly requirements. The monthlies account for 87 of 200 requirements—the sum of all five shipyards.

The objective of the shipyards' NPDES sampling program should be to accurately describe the composition of the discharge and/or the effects of that discharge on the surrounding environment. Too few samples, or samples that are too far apart in time, are unlikely to reflect either the average or the extreme conditions of the discharge. The result can be an NOV because a typical sample overestimated the concentration of a pollutant in the discharge. Similarly, an inadequate sampling program can underestimate the concentration of the pollutant in the discharge, with deleterious consequences for the environment. The trade-off, of course, is between collecting enough samples to

generate representative data and the cost of collecting and analyzing those samples. Excessive monitoring can be, on the other hand, prohibitively expensive.

In general, monthly requirements are suitable for the characterization of effluent concentrations at most outfalls because a balance of statistical power and cost-effectiveness is maintained. However, the shipyards should negotiate with the regulators for monitoring frequencies that best suit their individual situations. In some cases, discharges are not routine enough to allow strict adherence to the assigned periodicity, and these cases must be explained to the regulators (See Methods of Sampling section). Moreover, if shipyard personnel disagree with a monthly sampling plan for a certain pollutant it believes is absent from the discharge, they may want to request a more frequent sampling period (e.g., daily or weekly) for 6 to 12 months to substantiate this position. Regulators may be receptive to remove the requirement if a valid data set is obtained, and it contains only "non-detects." For example, if the organic compounds monitored at Long Beach were prescribed because of the widespread sediment pollution in the harbor (as mentioned earlier in the Permit Description section), LBNSY could request quarterly monitoring for 1 year. If the four analyses show non-detect, the shipyard could then request removal of any future monitoring for those parameters. Monitoring periodicity should be determined case by case. The proper selection of monitoring periodicity will also support the development of a long-term data set in preparation for risk-based assessments.

Expression of Pollutant Limits. NPDES regulations allow the expression of discharge limits as concentration in the effluent, total mass discharged, or both (40 CFR 122.45). The shipyards should strive to have only one set of units, either concentration or mass, for each of their discharge limits. This will give them greater flexibility to adapt to changing operations and workloads. Permit writers prefer concentration units because water quality standards are usually expressed in these terms.

Another important issue is the temporal basis for a limit versus the period over which the measurement applies. As tables 3 through 7 show, many limits have daily or monthly periods. However, the samples collected to decide whether the shipyard is within these limits are collected on a much longer time scale: half-year, 1 year, 5 years. There is no consistency between when samples are taken and when effluents are discharged. This disparity among temporal expressions of discharge limits, the monitoring periodicity, and the actual effluent discharge complicates the issues and limits the ability of the NPDES program to make environmentally relevant measurements.

Stringency of Limitations. As noted in figure 1 and the discussions that followed, the shipyards have been saddled with NPDES discharge limits that are below ambient conditions, do not allow for the mixing of the effluent and the receiving waters, and sometimes are below the analytical detection limits of the standard EPA method for that pollutant. Therefore, shipyards should carefully review proposed effluent limits when they first receive the draft NPDES permit. They should negotiate with the regulators if those limits are not achievable. Of course, the shipyards must be prepared to present scientific evidence and/or compelling arguments that the limits are unrealistic. If negotiations fail and the evidence is strong enough, NPDES regulations allow permittees to proceed through administrative and judicial hearings.

Specific Recommendations

The following recommendations are shipyard-specific and are intended to help each shipyard achieve NPDES compliance under the current regulatory scheme. These recommendations focus on adding, deleting, or modifying current NPDES permit requirements, gathering new data, and applying new pollution prevention practices.

Long Beach

- Obtain a copy of the Fact Sheet so the shipyard can understand the basis for imposed limits and monitoring requirements.
- Negotiate to remove limits that were uniquely derived from the now-invalid Enclosed Bays and Estuaries Plan.
- Request a justification for the inclusion of the 28 organic compounds, the disparities between the temporal bases and monitoring periodicities, and the effluent limits that fall below capabilities of standard analytical methods.
- The shipyard should ask the regulators to remove the 30-day limits adopted from the now invalid Bays and Estuaries Plan.

Portsmouth

- Portsmouth has had no major compliance problems. Nonetheless, the shipyard should consider voluntarily participating in the new Toxics Monitoring program. Participating in this program could help the shipyard by demonstrating a proactive environmental attitude to the regulators, collecting data to prove whether the shipyard is impacting the Piscataqua River, and providing a scientific basis to argue for or against specific limits in the permit that is up for renewal in 1997.

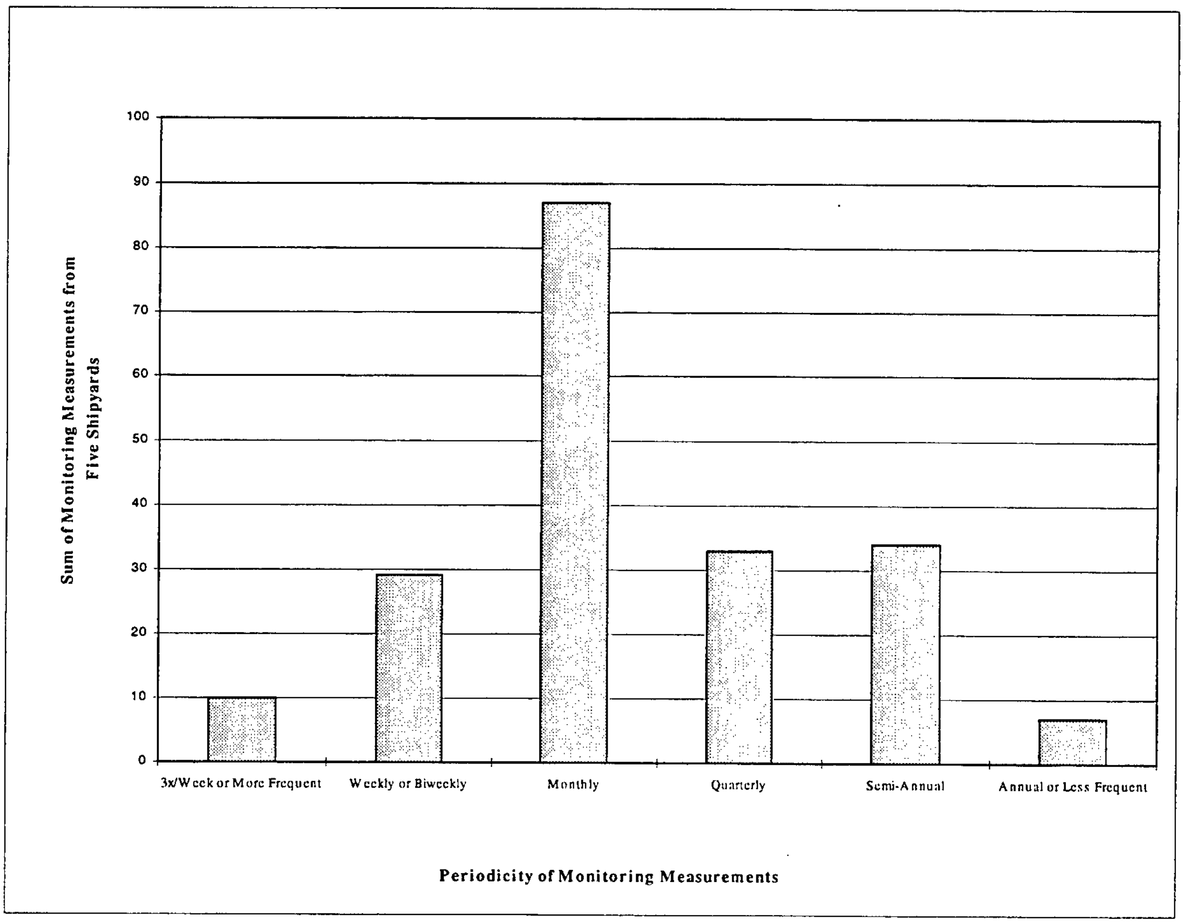

Figure 9. Distribution of monitoring periodicities.

Puget Sound

- Gather data to determine the true DM:TRM ratio for copper in the shipyard's discharge effluent. There is some evidence the real ratio is larger than 1:3; if this can be substantiated, it would provide justification for relaxing the current permit limits for copper.
- Consider cleaning the dry-dock drainage tunnels, as Norfolk has done, to reduce the copper loading.
- Request an explanation of the mixing zone calculations used to derive the current permit limits.

Norfolk

- Attempt to resolve the discrepancies between the Fact Sheet and the permit. At the very least, these discrepancies obscure the justification for the permit requirements, conditions, and limits. They may show that the shipyard is performing unnecessary or irrelevant monitoring.
- Discuss with the regulators why specific point-source parameters were assigned to outfalls that convey mostly stormwater. The shipyard should argue that the recently proposed (and nearly finalized) stormwater regulations could serve as the basis for assigning parameters developed for the Multi-Sector Shipyard permit. Further characterization of the outfalls in question may be necessary.
- Review the proposed monitoring frequency. In the short-term, the proposed frequency may be beneficial to the shipyard by helping to mitigate seemingly excessive monitoring requirements. In the long-term, it may hinder the collection of a good data set from which ecological risk can be assessed, monitoring requirements removed, and less stringent discharge limitations obtained.
- Re-examine the regulators' reasoning for not allowing mixing zones in the permit; the shipyard should contact personnel at PSNSY to investigate the reasons why the regulators in Puget Sound were allowed to establish mixing zones there.

Pearl Harbor

- Continue to investigate the problem of high nutrient levels in the groundwater that are leaking into the dry-docks. Agricultural runoff and decaying or marine biota may be responsible for the high levels of nitrates/nitrites and ammonia, respectively. The shipyard should investigate for other nutrient sources possibly overlooked.

General Recommendations To Improve Current Permit Compliance

The following recommendations provide a more scientific basis for NPDES permit requirements and conditions, ensure that the terms of the permit are agreeable to the shipyards, and demonstrate to the regulatory oversight agencies that the shipyards are moving in the direction EPA has recommended for the States. They are in order of ease of implementation, progressing from simple and short-term to difficult and longer term.

- **Continue Ongoing Pollution Prevention Efforts.** The shipyards should continue to evaluate BMPs in use by other shipyards and other commercial yards for potential adoption and implementation. They should also continue with plans to modify dry-dock designs to segregate process water from clean water.

- **Correctly Identify and Classify Outfalls.** The shipyards should conduct their own identification and characterization of outfalls to ensure they are assigned to the proper monitoring requirements and limits.

- **Critically Review All NPDES Requirements.** The shipyards should critically review all NPDES requirements when they first receive their draft permit. They should negotiate with the regulator to have unreasonable specifications changed or removed; in particular, the shipyards should critically examine the sampling design (frequency, method, location, etc), the units in which parameters are expressed, the form in which metals are expressed (dissolved versus total), chemical versus ecological limits, etc.

- **Draft Next Permit.** Shipyards can ensure more agreeable permit requirements and conditions if they consider drafting their own permit before it comes issued to them from the responsible regulatory agency. In addition to achieving better compliance, this will also serve to demonstrate the U.S. Navy's proactive stance to the regulatory agencies.

- **Use Available Data.** The shipyards should review the sediment contamination data generated under the IR and the dredging programs at their site for possible relevance to the NPDES programs.

- **Collect Additional Data.** If there are limits that are practicably unachievable, yet are justified by NPDES regulations and water quality standards, the shipyards should consider the possibility of collecting and presenting additional scientific data that might allow future removal of these requirements.

- **Gather Site-Specific Data.** The shipyards should coordinate with their regulators and other permittees to develop site-specific data and criteria so that more accurate and relevant requirements can be assigned in future permits. Studies that the shipyards should consider include the following:

  - Site-specific water quality criteria by using WER or recalculation procedures.
  - Harbor mixing and contaminant transport modeling.
  - Determination of bioavailable and toxic fraction/species of metals.
  - Chemical translators for dissolved and total recoverable metals.
  - Toxicity testing coupled with measured or predicted pollutant exposure levels in the harbor or rivers.
  - Calculation of mass balance of specific pollutants.

All of these efforts would benefit the shipyards by assisting regulators in determining Total Daily Maximum Loadings for specific pollutants to derive more equitable Wasteload (for point source) and Load (non-point source) Allocations, which could then be used to calculate more reasonable effluent limits in shipyard NPDES permits.

- **Conduct More Relevant Monitoring.** The shipyards should work with regulators to replace some of the effluent monitoring requirements of their permits with more relevant monitoring of sediment and tissue concentrations, and measures of biological and ecological effects.

5. STORMWATER PROGRAMS

INTRODUCTION

Stormwater runoff is part of the natural hydrogeologic cycle. It occurs when precipitation cannot completely percolate into the ground. However, human activities can affect the amount and composition of stormwater runoff. Construction activities may alter the natural drainage patterns of a region, in part by creating an impermeable ground cover that concentrates stormwater and other non-point source flows. Industrial and domestic activities may add pollutants to this runoff before it discharges into adjacent receiving waters. Recent studies by federal and State water pollution control authorities have shown that stormwater runoff is a major source of water pollution (USEPA, 1992b). Consequently, stormwater runoff is now receiving increased attention by local agencies, community groups, and concerned citizens familiar with the naval shipyards. Their concerns include the decline of local fisheries, restrictions on the human consumption of finfish and shellfish, and restrictions on recreational activities such as swimming and boating. Many states and municipalities have responded to these concerns with actions to manage non-point source pollution more effectively.

There are, however, many overlaps and ambiguities among programs addressing non-point and point sources of pollution. The Coastal Non-Point Pollution Control program developed by EPA provides guidance for developing and implementing coastal non-point pollution prevention programs that are not addressed under NPDES stormwater permits. Unlike the conventional end-of-pipe treatment approach, stormwater permits are based on pollution prevention. Naval shipyards are all required to address stormwater runoff under their NPDES programs. The U.S. Congress has enacted legislation directing the EPA to assist in administering programs to control stormwater runoff (USEPA, 1980). In particular, EPA was directed to develop regulations governing certain high-priority sources of stormwater pollution. Pursuant to the Clean Water Act (CWA) of 1972, most industries are required to obtain coverage under an NPDES permit for discharges of stormwater runoff. The EPA has identified shipyards and associated industrial activities as high-priority sources for potential contamination of the environment from stormwater runoff (USEPA, 1993c). These permits authorize the discharge of stormwater and prohibit the discharge of pollutant and non-stormwater into stormwater conveyance systems (Jayne, 1993).

Unintentional discharges continue to be a problem at the naval shipyards. The shipyards were constructed when it was acceptable practice to discharge process wastewater and sanitary wastes directly into adjacent waters. As environmental regulations have restricted these practices, the shipyards have altered and cross-connected the piping systems to redirect wastes into the sanitary sewer. These reconnections have created a complex maze of sometimes old, corroded, and broken underground pipes. It is often unclear which drains lead to the sanitary sewers and which lead to the stormwater system. In other areas, regional land subsidence and tidal back flows have caused in-flows of water to the stormwater systems that subsequently discharge into the regional environment. Efforts at the shipyards are underway to investigate and address problems with cross connections and to stop these unintentional discharges.

BACKGROUND

An Industrial Stormwater permit has three major requirements (Jane, 1993, p. 10). The permit requires dischargers to:

- Eliminate all non-stormwater discharges (including illicit connections) to the stormwater conveyance system;
- Develop and implement a SWPPP; an SWPPP is a site-specific plan to implement a BMP plan to reduce or eliminate the discharge of pollutants to stormwater;
- Develop and implement a monitoring and reporting program; this program is intended to demonstrate compliance, implement the SWPPP, and measure the effectiveness of the BMPs.

An EPA Final Rule of 16 November 1990 stated stormwater discharges associated with industrial activities will require a permit (USEPA, 1992b). This rule encompasses selected industries and all federal facilities, including naval shipyards. All shipyards visited during this study have or are preparing a stormwater permit.

Despite the shipyards' progress on this front, new federal regulations titled Storm Water Discharges from Industrial Activity, are due later this year. They will place more specific requirements on shipyard activities (USEPA, 1993c) and will require changes to routine shipyard operations that were given little regulatory oversight in the past. These regulations would add all non-stormwater discharges under the shipyard's existing NPDES permit, including bilge and ballast water, sanitary wastes, pressure wash water, and cooling water that enters into stormwater drains. The regulations also have stringent monitoring requirements. To obtain an exemption from any future stormwater monitoring requirements, a permit holder would be required to use clean/ultraclean techniques to measure metal concentrations in their discharges.

These new regulations suggest a trend toward more control of stormwater by the States and EPA. Initially EPA required only a general permit for shipbuilding and repair facilities. These early permits were designed to generate data the EPA needed to understand industrial stormwater flows and associated pollutant loading. Monitoring requirements were limited to pH, oil and grease (O&G), COD, TSS and pollutants from a facility that might become part of the stormwater runoff. EPA also intended these early permits to measure the success of control efforts.

The EPA is now refocusing the emphasis of stormwater permits on industrial activities that are known contributors of significant contaminants. As part of this shift, the new EPA guidance on stormwater monitoring (USEPA, 1993c, p. 76) includes two sets of testing requirements: the suggested[6] set and an alternate set. The latter is similar to the suggested set but has a different monitoring scheme. If this guidance becomes final as printed, permittees can choose which of these two monitoring schemes to implement.

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[6] According to the EPA Federal Register (USEPA, 1993c), these requirements are referred to as proposed monitoring requirements. However, to avoid confusion, they are referred to in this document as suggested monitoring requirements.

The suggested and alternate monitoring options would exceed the monitoring requirements of the existing stormwater permits. The suggested testing option adds total recoverable copper, zinc, lead, arsenic, iron, and total nitrogen (nitrate + nitrite) to the suite of monitored materials. It would require quarterly samples during the second and fourth years of the 5-year permit. The results from the analyses during the second year of the permit would determine the monitoring requirements for the fourth year. The alternate monitoring option would require only annual measurement of total recoverable copper, zinc, and lead. However, it would add an acute WET test to the analysis suite. EPA expects to finalize these testing schemes in 1995.

The suggested and alternate options have their advantages and disadvantages. A lack of rainfall during a given quarter of the year could make it difficult to comply with the monitoring requirements of the suggested option. The alternate testing option with an annual sampling requirement would thus appear to be a more consistent approach. However, annual sampling might be too infrequent to provide the shipyards with enough empirical information to make informed management decisions (e.g., where contaminant sources are coming from).

Under EPA's new stormwater permit program, monitoring will focus on the shipyards' efforts to reduce pollution. Monitoring will be more specific and more tailored to the specifics of the shipbuilding and repair industry. However, the permits could also reduce the monitoring requirements for a facility. For example, a facility with two or more outfalls that have substantially the same effluents would only be required to monitor one of the outfalls. This type of "representative discharge monitoring" (USEPA, 1993c, p. 61171), if applied properly, could save the shipyards money. It would allow shipyard personnel to decide which outfalls are representative for drainage areas and exclude any similar outfalls. The shipyard would report the results for the representative discharge only.

Even before EPA published its final guidance on shipyard permits, there was a push from community groups for more regulatory oversight. For example, the National League of Cities has asked EPA to require all NPDES permit holders to meet the water quality standards for stormwater discharges specified in the NPDES permits (Bureau of National Affairs, 1995b).

CURRENT STATUS

The shipyards are required by their Stormwater permits to develop an SWPPP. The SWPPP defines the procedures that the shipyards will use to prevent pollutants from entering their stormwater system and discharging into the receiving waters. Typically, BMPs are established to prevent materials from entering the stormwater system. The shipyards have developed BMPs to identify and control water from painting activities, machinery washdowns, boiler blowdowns, and other process wastewater discharges from entering the stormwater system. The SWPPP must address these flows from normal operations, and from construction, unauthorized connections, and combined sewage overflow. Most BMPs attempt to eliminate these problems through education of the shipyard workforce and establishment of a system of self-monitoring. They may also employ technical solutions, including engineering modifications, smoke and dye tracer studies, and maintenance and repair of the stormwater system.

The shipyards have a long history of preparing BMPs for their NPDES permits. Often overlooked in this process, however, is that the problems addressed in one shipyard's SWPPP and monitoring plan, which appear unique to that facility, may occur at other shipyards. This commonality or similarity of requirements underscores the need for the shipyards to share information about their SWPPPs and the results of applying these practices. As an example, ground subsidence at LBNSY

has created a situation where periodic tidal back flows enter the stormwater system. In at least one location, this back flow reaches the surface of a parking lot. As the tide ebbs, contaminants from the parking lot are incorporated into the stormwater system. While ground subsidence is not a widespread problem at the shipyards, tidal flushing of the stormwater pipes may be a problem. Thus, an extreme situation at one shipyard may have application for all the shipyards. Similarly, LBNSY has experienced combined sewer overflows (CSOs) and partial flooding when above-normal rainfall events recently exceeded the capacity of their stormwater system. Unusual weather conditions could create a similar situation at other shipyards. Likewise, a company leasing land at LBNSY for industrial operations (curing rubber for sonar domes) has a separate NPDES permit. This permit allows the company to intermittently discharge up to 16,000 gallons of non-contact cooling water into the shipyard's storm drains system. The LBNSY environmental staff is concerned that this discharge might contain non-permitted pollutants or exceed the permitted volume of discharge.

At PNSY, bird guano on the rooftops of buildings has been associated with elevated counts of fecal coliform bacteria in the rain that washes into their stormwater system. The shipyard has measured coliform counts in their stormwater equivalent to a 0.2% solution of sanitary sewage (Dames and Moore, 1992). Although bird feces have been recognized only at PNSY, similar conditions may exist at the other shipyards.

Puget Sound has experienced a particularly vexing problem with the standard definition of a "first flush" because of the amount of precipitation at the shipyard. EPA defines a first flush as the runoff from a rainfall event that is greater than 0.1 inches, within 50% of the average rainfall for that locale, and preceded by a minimum of 72 hours of dry weather (Rakoczynski, 1994). The Bremerton area is often subjected to continuous light rainfall for weeks, so no clear beginning or end of a storm event meets these criteria. The shipyard takes its samples within the first 30 minutes, and if the storm meets the EPA definition of a first flush, it is used. Given the unpredictability of the weather conditions, other shipyards could experience similar situations.

The misclassification of stormwater outfalls under NPDES is a potentially more serious problem. If a shipyard cannot establish that an outfall discharges only stormwater, regulators may include the outfall under their NPDES permit. Given the disparity in the monitoring requirements of NPDES and stormwater permits, this can be an important consequence. The problem is that cross-connections, inflow from ground water, and other factors often make it difficult for the shipyards to know which outfalls carry primarily stormwater. At NNSY, for example, the Virginia Department of Environmental Quality has included several outfalls that carry only stormwater and non-point source pollutants under the shipyard's NPDES permit (Virginia Department of Environmental Quality, 1994). Other shipyards may face similar situations if they cannot demonstrate the source and composition of the discharges from their outfalls.

An analogous situation exists at PHNSY. Nutrients dissolved in the groundwater seep into the dry-docks and are discharged through shipyard outfalls. The State of Hawaii regulates these discharges as point sources from the shipyard dry-dock rather than a non-point source. Similarly, an underground oil plume intermittently discharges free product through the stormwater system. While this is a facility-wide issue, it causes the shipyard to permanently boom its storm drains and collects the oil after any discharge into the receiving waters.

The shipyards' Stormwater programs require each facility to measure different parameters. Table 8 provides a summary of monitoring efforts and comparison to future requirements under the EPA's proposed rule (USEPA 1993c). Except for the acute WET test, PSNSY already meets the requirements of the alternate monitoring option. The permits prepared by NNSY and PHNSY include most

of the parameters required by the suggested and the alternate options of the proposed rule. NNSY and PHNSY do not monitor copper, lead, or zinc under their current stormwater permits. However, Norfolk does monitor metals for their NPDES permitted outfalls. Long Beach will need to add lead, zinc, and copper to its minimum monitoring requirements of the suggested or the alternate testing options. Pearl Harbor is still experimenting with an acceptable stormwater sampling design, while PNSY is waiting for the publication of the EPA final permit before choosing a course of action on its stormwater monitoring plan.

Many provisions of the NPDES and Stormwater programs are similar. These provision include the requirements for BMPs, record keeping, training, spill prevention and a response program, pollutant source identification, and facility inspections. The two programs differ primarily in their specific limits on contaminants. There are no discharge limits under the Stormwater program.

Based on the rapid development of EPA's Stormwater program, the shipyards may soon have limits imposed on their stormwater discharges similar to those of NPDES (see table 2 for comparison). Currently, the shipyards must retain test results from stormwater discharge monitoring for possible inspection and review. However, there are no regulations or specific numeric limits on any stormwater discharges.

Table 8. Stormwater parameters at naval shipyards.

Parameter	Long Beach (basin No.)	Portsmouth (outfall No.)	Puget Sound (outfall No.)	Norfolk (outfall No.)	Pearl Harbor (drain No.)
	See Appendix B, Map 1	See Appendix B, Map 2	See Appendix B, Map 3	See Appendix B, Map 4	See Appendix B, Map 5
Aluminum		1			
Ammonia-N					N F1-8, A4-9, & F6-7
Arsenic (A)		1	002, 003, 006, 010, 012, 013, 014, 025, 028, 030, 040, 052		
Asbestos	2				
Barium		1			
BOD			002, 003, 006, 012, 013, 014, 022, 025, 028, 040, 052		G F1-8, A4-9, & F6-7
Cadmium		1	002, 003, 006, 010, 012, 013, 014, 025, 028, 030, 040, 052		
Chromium		1	002, 003, 006, 010, 012, 013, 014, 025, 028, 030, 040, 052		
COD (B)		1	002, 003, 006, 012, 013, 014, 022, 025, 028, 040, 052	008, 009, 911, 012, 915, 016, 917, 021, 025, 031, 032, 033, 034, 037, 039, 042, 943, 044, 045, 057, 071, 972, 073, 076, 078, 980, 981, 083-089, 092, 993, & 900	G F1-8, A4-9, & F6-7
Copper (A&B)		1	002, 003, 006, 010, 012, 013, 014, 025, 028, 030, 040, 052		
Cyanide	1,2,3,4,5,6,7,8,9				
Fecal Coliform		1			N F1-8, A4-9, & F6-7
Flow (B)	1,2,3,4,5,6,7,8,9		002, 003, 006, 010, 012, 013, 014, 022, 025, 028, 030, 040, 052	008, 009, 911, 012, 915, 016, 917, 021, 025, 031, 032, 033, 034, 037, 039, 042, 943, 044, 045, 057, 071, 972, 073, 076, 078, 980, 981, 083-089, 092, 993, & 900	G, N F1-8, A4-9, & F6-7
Iron (A)		1			
Lead (A&B)		1	002, 003, 006, 010, 012, 013, 014, 025, 028, 030, 040, 052		
Manganese		1			
Mercury			002, 003, 006, 010, 012, 013, 014, 025, 028, 030, 040, 052		
Metals	1,2,3,4,5,6,7,8,9				
Nickel		1	002, 003, 006, 010, 012, 013, 014, 025, 028, 030, 040, 052		
Nitrate (A)		1			G,N F1-8, A4-9, & F6-7
Nitrite (A)		1			G,N F1-8, A4-9, & F6-7
Nitrogen (A)					(total) G,N F1-8, A4-9, & F6-7
Oil & Grease (B)	1,2,3,4,5,6,7,8,9	1	(TPH) 002, 003, 006, 012, 013, 014, 022, 025, 028, 040, 052	008, 009, 911, 012, 915, 016, 917, 021, 025, 031, 032, 033, 034, 037, 039, 042, 943, 044, 045, 057, 071, 972, 073, 076, 078, 980, 981, 083-089, 092, 993, & 900	G,N F1-8, A4-9, & F6-7
Ortho Phosphate		1			
PCB's	4				
pH (B)	1,2,3,4,5,6,7,8,9	1,2,3,4,5,6,7,8,9,10, 11,12,13,14,15	002, 003, 006, 012, 013, 014, 022, 025, 028, 040, 052	008, 009, 911, 012, 915, 016, 917, 021, 025, 031, 032, 033, 034, 037, 039, 042, 943, 044, 045, 057, 071, 972, 073, 076, 078, 980, 981, 083-089, 092, 993, & 900	G,N F1-8, A4-9, & F6-7
Phenols	1,2,3,4,5,6,7,8,9				
Phosphorus					(total) G,N F1-8, A4-9, & F6-7
Semivolatile Organics	1,2,3,4,5,6,7,8,9		003, 006, 013, 028, 052		
Silver		1			
Specific Conductance	1,2,3,4,5,6,7,8,9				N F1-8, A4-9, & F6-7
Temperature			002, 003, 006, 010, 012, 013, 014, 022, 025, 028, 030, 040, 052		N F1-8, A4-9, & F6-7
Tin		3,4,5,6,7,8,9			
TOC	1,2,3,4,5,6,7,8,9	1			
Toxicity Acute WET (B)					
Turbidity					N F1-8, A4-9, & F6-7
TSS (B)	1,2,3,4,5,6,7,8,9	1	002, 003, 006, 012, 013, 014, 022, 025, 028, 040, 052	008, 009, 911, 012, 915, 016, 917, 021, 025, 031, 032, 033, 034, 037, 039, 042, 943, 044, 045, 057, 071, 972, 073, 076, 078, 980, 981, 083-089, 092, 993, & 900	G,N F1-8, A4-9, & F6-7
Volatile Organics	1,2,3,4,5,6,7,8,9				
Zinc (A&B)		1	002, 003, 006, 010, 012, 013, 014, 025, 028, 030, 040, 052		

Items highlighted in gray are requirements under the new EPA rule - Storm Water Discharges associated with Industrial Activity from Ship and Boat Building or Repairing Yards.
A= Proposed Quarterly Monitoring Requirements.
B= Proposed Annual Alternative Monitoring Requirements.
G= General Permit Requirements
N= Notice of Intent Requirements.

RECOMMENDATIONS

- **Source Characterization.** Stormwater regulations are relatively new for the shipyards. EPA is also completing new stormwater monitoring regulations for shipbuilding and repair facilities. Therefore, it is essential that the shipyards characterize the major sources of stormwater contamination and identify the discharge locations. Characterization of the outfall should include toxicity tests and sediment and bulk chemical analysis water column analyses at consistent sampling intervals. These analyses should also address the depositional characteristics of contaminants in the sediments at storm drain outfalls that act as long-term contaminant sources. Shipyards should review existing sediment and receiving water data related to all of their outfalls.

- **Sample Frequency.** The shipyards should sample at least four storm events per year (preferably seasonally). Although seasonal sampling might not be feasible, samples from four storm events are the minimum required to evaluate stormwater variability and to provide representative data for management decisions.

- **Heavy Metals Monitoring.** The shipyards should include monitoring for copper, lead, and zinc in their stormwater discharges as required by forthcoming regulations. The addition of these metals applies specifically to LBNSY, NNSY, and PHNSY.

- **Communications.** The shipyards should increase the exchange of information on their Stormwater programs, including the efficacy of testing methods, the nature and sources of stormwater contaminants, and the effectiveness of control measures. Some problems, such as high fecal coliform counts, might exist at shipyards that are unaware of them.

- **Removal of Requirements.** If the toxicity tests fail to find an adverse effect from the stormwater effluent, the shipyards should negotiate with the regulatory agency to reduce the number of outfalls monitored. In addition, toxicity testing can become a valuable tool for validating and screening the effectiveness of the SWPPP.

- **Toxicity Testing.** The shipyards should consider using toxicity tests to develop appropriate stormwater monitoring requirements and to classify outfalls under the proper regulatory programs. EPA recommends the WET test. However, other toxicity screening tests are available at minimal cost that would characterize the biological effects of the effluent. In particular, the PSNSY is testing the QwikLite bioassay developed at NRaD (Lapota et al., 1994) as a possible screening tool for stormwater effluents. The QwikLite test is currently undergoing evaluation by ASTM.

- **Coordinated Sampling.** The shipyards should integrate the monitoring efforts of their Stormwater program, the IR, and their NPDES permits. The regulatory requirements for each program are separate. However, some of the monitoring can be coordinated. The integration should use sediment data and relate empirical data derived from NPDES sampling efforts. This would save money and avoid duplicating efforts. A single permit would save time by coordinating sampling and analysis plans. It would also save money by combining sampling and analytical costs, and by combining the permit renewal efforts. Of the five shipyards surveyed in this study, only NNSY and PSNSY have integrated the monitoring requirements of their stormwater and NPDES permits. Long Beach, PNSY, and PHNSY monitor their stormwater and NPDES outfalls for similar parameters, but measure and report the results independently.

- **Electronic Record Keeping.** As noted in section 9 of this report, it is important to keep as many records as possible in electronic form. For the Stormwater program, the requirements for and specification of these electronic records should be included in the SWPPP and monitoring plan. These documents themselves should be retained in electronic form, as should spill logs, field notes, monitoring reports, etc.
- **Ecological Effects.** Monitoring is a means to understand the nature and extent of stormwater effects. Discharges can be beneficial or detrimental based on the interactions of the pollutants with the environment. Measuring the effects will help to establish the interaction of toxic materials and the environment. It can also help to control contaminants that are a potential problem (Suter III, 1993). This understanding should be the primary goal of all Stormwater programs at the shipyards. To obtain data that is representative of the regional ecological conditions, samples must be taken in places other than simply at the end of a discharge pipe. They should focus on gathering data that can provide an understanding of the temporal and spatial distribution of contaminants and their potential effects on the surrounding ecosystem.

ADDENDUM

Since the initial writing of this document, the USEPA has published the Final National Pollutant Discharge Elimination System Storm Water Multi-Sector General Permit for Industrial Activities. This final guidance replaces the proposed guidance that is discussed throughout this document. The new storm water permit will apply to some of the shipyards. The NRaD team is working with shipyard personnel to implement the requirements, as necessary. Although this may affect the way that the shipyards implement their Stormwater programs, the recommendations made at the end of this section are still relevant.

6. INSTALLATION RESTORATION PROGRAMS

INTRODUCTION

The naval shipyards use many industrial operations. As such, they have a long history of using toxic and hazardous materials. Past hazardous waste disposal methods, although acceptable at the time, have frequently been the source of long-term ground and water contamination. Exposure to many of these contaminants can have significant effects on human health and natural ecosystems (Arbuckle et al., 1991). Concern about exposing sailors, civilian employees, the general public, and the environment to these materials underlies the U.S. Navy's current efforts to clean up previously disposed materials and to prevent the release of hazardous materials in the future.

The shipyards are also located along coastal, estuarine, and riverine environments. Understanding the ecology of these environments is, therefore, a necessary prerequisite to assessing the effects of hazardous materials released from the shipyards. Sediments, in particular, may act as a sink for contaminants released from NPDES outfalls, storm drains, landfills, disposal pits, UST sites, and surface or groundwater. Unfortunately, the identification, evaluation, and remediation of these sites have focused on the risk to human health while ecological health has not always been adequately considered. The shipyards need broader, multidisciplinary perspectives and closer coordination among Installation Restoration (IR) and other regulatory programs concerned with the aquatic environments of the shipyards.

The IR programs at the shipyards are designed to identify, assess, characterize, clean up, and control contamination resulting from hazardous material spills or hazardous waste disposal operations before 1980. The shipyard IR programs integrate requirements from three laws and regulations (Department of the Navy, 1994):

- The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), and regulations issued under these acts or by State law
- Underground Storage Tank Regulations (UST)
- Resource Conservation and Recovery Act (RCRA)

CERCLA's scope is the broadest of these environmental statutes, encompassing air, surface water, groundwater, soil, and sediments. A CERCLA response or liability may be triggered by the release or "threat of" release into the environment of a hazardous substance, pollutant, or contaminant (Arbuckle et al., 1991). As part of the IR process, a work plan for a Remedial Investigation/ Feasibility Study (RI/FS) is developed and executed. This extensive technical study defines existing contaminants, their migration pathways, and the potential risks to human health and the environment (Department of the Navy, 1992). Included within the initial Site Investigation (SI) is a determination of cleanup levels. These cleanup options and levels are not a fixed set of requirements. Several factors are considered to establish reasonable cleanup levels including the proximity to regional groundwater and other sensitive areas and types of existing contamination. Historically, the RI/FS component has been the most time-consuming portion of the IR process. As soon as possible after a RI/FS has been identified, the shipyard must join a Federal Facility Agreement (FFA). The FFA is a legal agreement that establishes the roles and responsibilities of the State, EPA, and the U.S. Navy during cleanup and remediation efforts. During the restoration process, the U.S. Navy with the State and EPA with advice from members of the Restoration Advisory Board (RAB), must determine the cleanup options, the level of cleanup, and the extent of cleanup investigations.

Within the IR process is a requirement for a baseline risk assessment that specifically addresses and evaluates the potential threat from an identified IR site to human health and the environment. This risk assessment is a focused effort on the flora and fauna in and around an identified IR site. Ecological risk assessment, as practiced within the IR process, is more narrowly defined than the approach proposed in this report for the integrated marine environmental compliance programs at the naval shipyards. (The programs proposed for the shipyards will span the full range of the shipyard's environmental programs and examine a wider spectrum of ecological conditions.)

The enactment of CERCLA in 1980 required the U.S. EPA to develop "criteria" for determining priorities among sites needing remedial actions. It also required EPA to develop and maintain a National Priorities List (NPL) of sites that have been examined and ranked according to these criteria (Department of the Navy, 1992). Sites are given various scores for waste volume, waste toxicity, distance to population, and distance to underground drinking water. Under the current EPA policy, any site that receives a score of 28.5 or above will be included on the NPL (Arbuckle et al., 1991).

The more recent Corrective Action requirements under RCRA and the investigations of leaking USTs are programs that are now being coordinated within the U.S. Navy IR program. RCRA Corrective Action is a regulatory program that investigates and remediates more recent (contaminated after 1980) hazardous waste sites at permitted facilities. The CERCLA and RCRA national standards are designed to protect human health and the environment. Leaking Underground Storage Tank investigations have focused on the location of the tanks, their past and current contents, and the possibility they have leaked. Removing a UST requires an assessment of surrounding soil. Any soil determined contaminated based on State or Federal limits is removed or remediated. Soils that cannot be easily remediated or areas with extensive contamination are included within the IR program. The shipyards are removing tanks with potential problems, including those that do not meet present regulatory requirements. All non-compliant tanks will be upgraded eventually to acceptable standards, replaced, or removed.

CURRENT STATUS

IR programs have traditionally examined terrestrial sites. They are beginning to trace contamination pathways into the marine environment. Runoff, leaching, and infiltration through contaminated sites have contributed to contamination of marine sediments at several shipyards. Frequently, rainwater and subsurface groundwater flow through the IR sites and eventually into the adjacent water body (Johnston et al., 1989). Investigation of these contamination pathways suggests that integrating the monitoring efforts of various regulatory programs could help to understand the extent of contaminant migration. Appendix B contains maps of each of the five shipyards. Each map shows the shipyard's IR sites, and stormwater and NPDES outfalls. This is important to examine because of the relationship that all these areas have to one another, and the types of cleanup activities that must undertaken.

The Long Beach, Puget Sound, and Pearl Harbor Shipyards have expanded their IR investigations by designating contaminated harbor sediments as separate sites. These shipyards have applied a tiered screening analysis of the sediments to meet regulatory requirements and to delineate the extent of contamination. In tiered screening analysis, sampling occurs in stages. After each set of analyses, the results are examined and the plan for subsequent sampling is modified to optimize the information obtained. Norfolk NSY has focused its efforts on current discharges, but it is not considering potential contamination of the marine sediments. The IR program at PNSY is addressing the potential contamination pathways to the groundwater and marine sediments as part of an estuarine ecological risk assessment (Johnston et al., 1994).

Long Beach Naval Shipyard

LBNSY has initiated an RI/FS at all of their IR sites. The draft final implementation plan of the RI/FS Sampling and Analysis Plan was submitted to SWDIV in April 1994. Some of the identified IR sites could contaminate marine sediments and groundwater through infiltration, leaching, or runoff of surface water. Because the shipyard is located in a heavy industrial area, the sediment contamination has been associated with multiple sources (EFD Southwestern, 1993b). The shipyard is using a tiered decision tree for its marine sediment-sampling plan. The decision tree begins with a screening-level analysis that includes chemistry, bioassays, and bioaccumulation tests. This tiered approach attempts to increase the cost effectiveness of both the sampling and the analysis.

At the same time, LBNSY is conducting an ecological risk assessment (ERA) of the sediments at the shipyard that should be completed by the end of the feasibility study. The risk assessment (EFD Southwestern, 1993b) will determine the general nature of the aquatic resources potentially at risk; evaluate potential exposure by direct measurement of bioaccumulation of contaminants by aquatic organisms, or through a bioaccumulation model calibrated with laboratory bioaccumulation tests; and evaluate potential impacts to aquatic resources.

"The remedial action objective (of the risk assessment) for non-human receptors is to minimize, to the maximum extent feasible, adverse environmental effects such as changes in population abundance, age structure, reproductive potential and fecundity, species diversity, and food web or trophic diversity" (EFD Southwestern, 1993b). A conceptual model for the sediments was developed and the exposure pathways were identified. As part of the risk assessment, groundwater analyses will be conducted at each IR site. The sediment analyses at Site 7 will include bioassays, bioaccumulation, benthic community analysis, water column effects, and specific contaminants of concern that include metals, organotins, semivolatile organic compounds, pesticides, and PCBs (Appendix B, page B-1)

The work plan for reviewing the sediments for Long Beach Naval Station includes a summary and evaluation of the data currently available for the potentially contaminated sites. The plan includes a conceptual model of each site that considers the nature and extent of contamination and potential exposure pathways. Finally, the plan includes an initial evaluation of the risks associated with each site. These evaluations define a set of data quality objectives for the RI/FS.

Two additional sources of potential contamination to the marine sediments at LBNSY are the City of Long Beach's Combined Sewer Overflow (CSO) and the oil pipelines located under the shipyard. The CSO discharges onto shipyard property during heavy rains, and these discharges are routed into the harbor through the shipyard's storm water system. There are several oil wells throughout the shipyard, and the pipelines carrying this oil occasionally break. The shipyard has maintained an active dialogue with the city and with oil refineries to assure adequate solutions to these problems.

The UST programs at the shipyard and the naval station have removed several old and abandoned tanks. At many locations, contaminants have leaked into the surrounding environment. Efforts are underway to determine the extent of contamination that exists. Required cleanup levels at these sites are not established. However, the shipyard has had some preliminary discussions with regulators concerning the possibility of using industrial instead of residential screening levels for any soil cleanup. The screening levels and associated cleanup levels are important to negotiate because they consider the level of effort required to clean up the soils. The industrial cleanup standards are less stringent because they assume that the future use of the site will be exclusively industrial. For the groundwater, the regulators considered using drinking water standards, but finally agreed to a less-stringent requirement because the regional groundwater would probably not be used for drinking.

This type of negotiation by the shipyard could save money because of the large difference among cleanup levels.

Portsmouth Naval Shipyard

The Portsmouth Naval Shipyard started the IR process in the 1980s. They began a RCRA Facility Assessment (RFA) in response to the Hazardous and Solid Waste Amendments of 1986 (HSWA) under RCRA. This RFI was lead by the U.S. EPA and identified 13 Solid Waste Management Units (SWMUs). Several of these SWMUs (Appendix B, page B-2) could contaminate the marine environment through leaching (McLaren and Hart, 1993). This initial process was terminated because in 1989 the shipyard initiated a Resource Conservation and Recovery Act (RCRA) corrective actions permit. The EPA recently ranked the shipyard under the Hazard Ranking System/National Priorities (HRS/NPL) List. Because of the listing, the shipyard started the transition to the CERCLA process.

The NPL ranking has added some new requirements for the shipyard. However, with regulator approval, some of these requirements can be satisfied by RCRA actions that are already completed. The current RCRA permit requires the shipyard to investigate all receptors and potential transport pathways for contaminants originating from the shipyard.

The RCRA Facility Investigation at PNSY triggered the need to assess the ecological risk of shipyard contaminants on the estuarine ecosystem (Johnston, 1994b). The risk assessment included an extensive sampling effort to characterize the sediments and surface waters of the Piscataqua River. Chemical contamination levels in seawater, sediment, and tissue samples were measured to evaluate the magnitude and distribution of contamination in the estuary. The sediment and tissue samples were analyzed for metals and organic compounds (PAH, PCB, and pesticides). Sediment toxicity was also analyzed at the stations around the shipyard to evaluate effects to aquatic resources.

As part of the risk assessment, a conceptual model was developed for the risk assessment. A regional hydrographic data model was then developed and data were collected and applied to a general fate and transport model for aquatic systems (Chadwick, 1993). The model was developed from DYNHYD3 (dynamic hydrodynamic model, version 3) in combination with TOXIWASP (Toxicological Water Analysis Simulation Program).

The main emphasis of the ERA for PNSY was on sampling in depositional areas of the estuary. Mussels, fish, eelgrass beds, and benthic organisms were sampled for potential ecological effects based on sediment quality values, sediment toxicity tests, benthic community data, and growth and chemical bioaccumulation tests (Johnston et al., 1994).

The ERA considered several sources of contamination, including IR sites (Appendix B, page B-2, SWMUs 5, 6, 8, 9 through 13, 16, 21, 23, 26, and 27). Based on the results obtained from the draft estuarine ecological risk assessment currently under regulatory review: "no major ecological impacts or widespread environmental contamination were detected" (Johnston et al., 1994). There are, however, indications of ecological stress in the depositional areas near the shipyard that need to be addressed.

The ERA for Portsmouth has developed an effective baseline of data and information on the potential impact of shipyard stressors on ecological receptors in the estuary (Marine Environmental Support Office, 1995). This information is being used to identify appropriate media protection standards (Johnston, 1994, 1995 in prep) and possible future cleanup levels necessary for remedial decisions at the shipyard.

In addition to the IR process, most abandoned or leaking USTs at PNSY have been removed and disposed. Residual contamination at these sites is being investigated under the shipyard's RCRA program. Although no specific regulatory cleanup levels have been established, the shipyard is hoping that appropriate levels based on actual land use will be used to determine cleanup levels. Some specific concerns are industrial versus residential screening levels for the cleanup of soils and how much contamination must be removed before the site is considered "clean." This determination of a cleanup level could also affect the cleanup levels that are established for the marine sediments.

Puget Sound Naval Shipyard

The RI/FS at PSNSY is being carried out in a tiered approach that addresses contaminated areas at the shipyard. This study will focus on the marine sediments (which are considered a single IR site) because they are the most likely repository for contaminants and the most direct exposure route that contamination could be leading to substantial environmental degradation (EFA Northwestern, 1994b). The EPA wants to wait until the RI/FS is complete before it will enter an FFA. The State of Washington Department of Ecology is reviewing the RI/FS and any public comments concerning the shipyard before it will support the FFA. The proposed investigation of marine sediments (EFA Northwestern, 1994b) is designed to characterize and evaluate the nature, magnitude, and extent of contamination; collect information necessary for an ecological and human health assessment; and acquire field data to evaluate the potential for natural recovery remedial alternatives.

In addition to the contaminated sediments already present in the Sinclair Inlet, solvents, petroleum hydrocarbons, and heavy metals might be leaching from IR sites into the inlet. This possibility will be investigated if indicated by the sediment studies (EFA Northwestern, 1994b).

PSNSY is in the preliminary planning stages for an ERA. The risk assessment will consist of four phases. The first phase is an ecosystem characterization that will profile the marine community and regional biological resources. The second phase is an exposure characterization that will fully describe the spatial patterns of chemical contamination in the sediments. This description will include discharges, current deposition, sedimentation rates, incorporation of exposure point concentrations, and a food chain model. The third phase is an ecological effect characterization in which toxicity testing results will be compared with benthic community data and bioaccumulation rates to extrapolate laboratory data and derive effects at the community level. The fourth phase integrates the results of the ecosystem and exposure effects characterizations to interpret the ecological significance of the nature, magnitude, and spatial scale of potential effects.

The shipyard has identified the essential components for the problem formulation. Overall, most conceptual problems focus on sediment contamination and its ecological effects. The shipyard has structured its proposed investigations into a tiered sampling approach to obtain sediment chemistry, sediment toxicity, benthic community bioaccumulation, water column toxicity, physical oceanographic, and geochemical data. The investigation will incorporate an analysis of possible migration of contaminants from the IR sites and existing outfalls (Appendix B, page B-3, Operable units B, 1, 2, 6, 7, 8, 9, and 10).

PSNSY is the only naval shipyard that must consider State-published guidelines for the cleanup of contaminated sediments. These are called the State of Washington Sediment Management Standards. Shipyard personnel are presently negotiating with the Washington Department of Ecology to determine the sediment cleanup levels that PSNSY must meet. The State regulators are pushing for the application of sediment quality standards instead of cleanup standards for actual remediation goals. The sediment quality standards are much more conservative than the cleanup standards because the

levels that are specified correspond to "a sediment quality that will result in no acute or chronic adverse effects on biological resources" (State of Washington, 1991). The cleanup standards are based on the goal of "reducing and ultimately eliminating adverse effects on biological resources and significant health threats to humans from sediment contamination" (State of Washington, 1991). Under the law, if cleanup is required, the site-specific standards developed are much more practical. Several things are considered, including net environmental effect, cost, and technical feasibility of any cleanup action. Evaluation of the natural recovery of contaminated sediments is also an important part of the determination of site-specific cleanup levels (Ginn and Pastorok, 1992). Other cleanup efforts are underway at PSNSY. The UST program has identified several sites. Most tanks are operational, but 28 are abandoned and not in use. Currently, eight of these abandoned tanks have been removed and no associated contamination was found. Other sites are still under review. Although the initial site investigation found no metal toxicity in the soil at the boundary of the marine sediments, bulk chemical analysis for metals yield results exceeding the State of Washington Model Toxics Control Act (MTCA) cleanup standards (Dawson and Laakso, 1992).

Norfolk Naval Shipyard

The Norfolk Naval Shipyard has completed the draft final version of an RI/FS study that focuses on four operable units. The RI/FS initial assessment indicated several media were contaminated from inorganic compounds in surface and subsurface groundwater (EFD Atlantic, 1995). According to the site management schedules of the RI/FS, Phase II for all operable units should be underway. Further sampling and analysis are also needed to define the extent of contamination and to describe the ecological and human health risks associated with the sites.

The UST sites at the shipyard have been closed and remediated or integrated in to the ongoing IR site investigations. Two of the operable units (OUs) are landfill areas that contain most of the wastes generated at the shipyard over the past decades (EFD Atlantic, 1995). These two OUs are located near Paradise Creek, along the southern boarder of the shipyard property. The sediment samples were compared to national sediment quality concentrations under the National Oceanic and Atmospheric Administrations (NOAA) National Status and Trends (NS&T) program. Under the NOAA program, sediments and surface waters are rated according to the effects that they could have on the surrounding ecology. Adverse effects on the biota are considered probable when contaminant concentrations are above the Effects Range-Median (ER-M) (EFD Atlantic, 1995). The surface waters at the sites exceeded the ER-Ms for pesticides, copper, zinc, chromium IV, nickel, mercury, cadmium, and beryllium. The levels of copper and beryllium were in the range of 1000 to 2000 ppm. The conclusion of the ecological evaluation was that further studies (such as toxicity tests) were needed to better understand the nature and extent of contamination.

Pearl Harbor Naval Shipyard

The work plan for Pearl Harbor sediments discusses contaminants of concern, potential transport, exposure pathways, and ecological receptors potentially at risk in the harbor. According to the work plan, the Phase I investigation will examine the spatial distribution of toxic sediments, the magnitude of toxicity, the potential for bioaccumulation, and any other potential sources of contaminant input into Pearl Harbor (Ogden Environmental, 1994). The design of the sampling and analysis plan focuses on chemicals that are of concern to regulators, the full range of TCL contaminants, and contaminants associated with historical land use. The Phase II investigations under the IR program at PHNSY will address concerns from monitoring programs into an ERA. The RI/FS also considers the dry-docks, NPDES outfalls, UST locations, stormwater drains, IR sites (Appendix B, page B-5, sites at Buildings 394, and 68), and other potential shipyard sources of contamination.

The only cleanup level discussed at the shipyard is 15,000-mg/kg lead in soil under Building 394. This recommendation is based on human health risk levels (Ogden Environmental, 1995). Finally, there are 26 USTs at PHNSY; all will be removed by 1998. One tank has been integrated into the IR program, and the remaining tanks are still under investigation (Site 394, page B-5).

CONCLUSIONS AND RECOMMENDATIONS

The IR and associated cleanup programs are designed to measure the nature and extent of the threat posed by a release of contaminants, and to evaluate proposed remedies. Some requirements under regulatory programs at shipyards are beginning to overlap. Puget Sound must submit the results of the IR sediment monitoring with its next NPDES permit renewal under a toxics cleanup program and the EPA Superfund program. Within the NPDES permit, it states "...this permit may be reopened and modified to establish effluent limitations and/or monitoring requirements if determined necessary to protect water or sediment quality from being degraded by discharges from the shipyard" (USEPA, 1992a). This overlap of programs is important to note because the IR program can have an affect on the way that the NPDES permit is applied to the shipyard.

Another trend among the shipyards is that the IR sites are no longer exclusively terrestrial. The marine environment adjacent to the shipyards is now being recognized as containing ecological receptors to contaminants. Sediments can accumulate contaminants from many sources, including outfall discharges, land-based IR Sites and other non-shipyard sources in the watershed (sewage treatment plants, non-point source runoff, atmospheric deposition, etc.) The Long Beach, Puget Sound, and Pearl Harbor NSYs have designated the marine sediments adjacent to their facilities as separate IR sites. In addition, PSNSY is required to report the results of sediment monitoring as part of their NPDES permit. Finally, stormwater, which the shipyards are just now beginning to monitor, represents a potentially significant source of sediment contamination (USEPA, 1992b). As stormwater monitoring results become available, they should be integrated into the sediment investigations at IR sites.

The shipyards have started to monitor various aspects of the regional ecology because contaminants are distributed throughout soil, sediment, groundwater, and the biota. The rate of contaminant transport is a function of numerous factors including wind patterns, water and current movement, sedimentation rates, regional hydrology, population dynamics and chemical/biological interactions. Transport models are beginning to be applied in ERAs at the shipyards; however, they need to be further integrated.

As investigations of IR sites have progressed, regional regulators have established specific cleanup levels. Negotiations have been initiated by shipyard personnel to apply appropriate cleanup levels during remediation efforts. In the past, cleanup levels were established in an attempt to be considerate of direct human consumption and exposure, including EPA's drinking water standards and residential soil level standards. Current cleanup efforts are based on more reasonably attainable levels. Shipyards located in industrial areas or with no nearby regional drinking water wells have successfully negotiated for the use of industrial cleanup levels that are still protective of human health and the environment.

Most of the environmental programs under which the shipyards are being regulated were initiated before the concept of an ERA was introduced. The shipyards are also considering ERAs as a mechanism to address environmental risk that is mandated by CERCLA. Portsmouth and Pearl Harbor have started ERAs of marine resources. These efforts are being coordinated with the regional and State regulators, NAVFAC EFDs, and with NRaD. Long Beach and Puget Sound Naval Shipyards are

gathering information on the marine sediments for use in an ERA. Finally, Norfolk has concluded, "more studies are necessary to better understand any associated ecological risk" (Atlantic Division, 1995).

Some general recommendations for the shipyards to consider are as follows:

- Shipyards should consolidate and coordinate data from the monitoring efforts of the Stormwater, NPDES, and UST programs with the IR program to comply with a broader spectrum of environmental mandates.
- Shipyards should attempt to identify contaminants in NPDES discharges that correlate with specific IR sites to determine remedial actions to address the problem of current operations adding to contaminants being investigated/remediated as "past" (before 1980) problems.
- Shipyards should perform more sediment sampling under the IR program. At most shipyards, the marine sediments are designated as IR sites and are an integral part of investigations; sediment sampling overlapping the IR and NPDES programs might require special agreement from their respective funding agencies.

Some specific recommendations are as follows:

- Long Beach NSY should consider contaminant migration from USTs as a possible source of sediment contamination. In addition, LBNSY should consider ongoing contamination from the stormwater, dry-dock, and NPDES outfalls to the marine sediments.
- Norfolk should take sediment samples in the area of the NPDES and stormwater outfalls to apply data across all programs, assess possible effects from any IR sites, and use in future ERAs. Because there are no sampling sites specifically designated in the Elizabeth River sediments, past migration of contamination from the land sites to these sediments might not be properly assessed. Not all of the ongoing discharges from the shipyard outfalls into the Elizabeth River have been identified as potential sources of sediment contamination. The shipyard should address the extent and magnitude of sediment contamination that potentially exists in the Elizabeth River outside the shipyard (Appendix B, page B-4, Sites 2, 3, 4, 6, 7, 9, 17).
- Shipyards should consider whether comparison to benchmark studies such as NOAAs NS&T program constitutes a Quantitative Risk Assessment; these studies are based on national averages and consider site-specific conditions.

7. DREDGING PROGRAMS

INTRODUCTION

Maintenance dredging is the periodic removal of sediments from navigable waterways to enable the safe passage of vessels. Construction dredging is the episodic removal of sediments to deepen, widen, or otherwise change the physical configuration of a water body so that a change in operations can be made (e.g., new pier construction or home-porting of a new class of ship). The shipyards' dredging programs are unlike their NPDES and Stormwater programs because they normally do not affect daily environmental compliance. They differ from the IR programs because the dredging of sediments is driven by shipyard operations instead of the statutory requirement for remediation. Whereas the U.S. Navy must investigate potential sites of contamination, it is not directed by any law or regulation to initiate dredging projects (unless required for cleanup under IR).

There are complex procedures governing the application and approval process for dredging and filling. There are at least eight federal statutes that have some applicability to the process: the Rivers and Harbors Act, the National Environmental Policy Act, the Clean Water Act, the Marine Protection Research and Sanctuaries Act (Ocean Dumping Act), the Fish and Wildlife Coordination Act, the Coastal Zone Management Act, the Endangered Species Act, and the Water Resources Development Acts. Primary authority and final approval of a dredging permit rest jointly with the Army Corps of Engineers (ACoE) and U.S. EPA for federal projects. Many Federal, State, and local agencies also have review authority.

Dredging has been a national issue for decades. The Clinton Administration established a federal interagency working group in 1993 to study and make recommendations to improve the dredging process (U.S. Department of Transportation, 1994). The President's goals included the following:

- Find ways to dredge the nation's ports without compromising environmental protection.
- Develop improved long-term management plans to help avoid delays caused by the "regulatory tangle."
- Resolve the navigational and environmental concerns that have long stymied dredging

On management of dredged material, the final report's recommendations focused on the following four problem areas:

- Strengthening planning mechanisms for dredging and dredged material management;.
- Enhancing coordination and communication in the dredging project approval process;
- Addressing scientific uncertainty about dredged material;
- Funding dredging projects consistently and efficiently.

To address the scientific uncertainty about dredging, the working group determined three specific needs:

- Clarify and improve the guidance used to evaluate bioaccumulation of contaminants from dredged materials;
- Identify the practical barriers to managing contaminated sediments and ways to overcome the barriers;

- Identify means to reduce the volume of material that must be dredged.

If a proposed dredging operation will result in aquatic disposal of dredged material, testing is required to determine whether the material is suitable for such a discharge. The primary guidance manual used for ocean disposal is a joint EPA/Army Corps publication referred to as the "Green Book" (USEPA and USACoE, 1991). The Green Book directs a tiered testing approach that includes, as necessary, physical, biological, and chemical analyses to estimate the potential for biological effects of dredged material disposal in the open ocean. Individual states may require additional testing as a prerequisite for their water quality certification of the dredging project. Some states have developed their own dredged material guidance documents to complement the federal guidance. For disposal into inland and near-coastal waters, the ACoE is also developing an Inland Testing Manual.

Dredging permits have been difficult to obtain because public interest groups often challenge the decisions of the granting agency. The entire permitting and testing process is often delayed by intense scrutiny from review agencies and extensive deliberation in environmental assessment, option selection, and other decision-making by the applicants. Finally, the actual testing of sediments to be dredged can be a controversial step in the process. Agencies often argue about the appropriateness and specific details of selected toxicity tests.

CURRENT STATUS OF DREDGING PROGRAMS AT NAVAL SHIPYARDS

The intensity of dredging activity across the naval shipyards varies. There is no active program at Long Beach, while the other shipyards have limited maintenance and project dredging. Portsmouth was dredged in 1968 and 1989. When NRaD visited the site, there were plans to dredge about 1200 cubic yards of sediment that had deposited in front of the three dry-docks. The shipyard had planned to dispose of the dredged materials in the ocean at an approved disposal site. However, initial chemical testing showed that high levels of PAHs that were a concern to the Army Corps of Engineers. Consequently, the shipyard was required to dispose of the materials upland at a sanitary landfill. The dredging and disposal operations were completed during the first few months of 1995.

Puget Sound requires no maintenance dredging. The last time the shipyard did any dredging was in 1987. When NRaD visited the MESO site, there was an ongoing project to dredge 100,000 cubic yards at Pier D for AOE oiler home-porting. The shipyard follows the Puget Sound Dredge Disposal Analysis (PSDDA) Dredged Material Protocols, which is the State guidance covering environmental testing for in-bay and upland disposal. The protocols do not exist as a separate document. They are a loose compilation of testing methods from which a sampling plan is selected or approved by PSDDA members. In addition to the ACoE and EPA, which are the primary approving authorities for ocean disposal in Washington, the PSDDA includes the State Departments of Ecology and Natural Resources.

The Supplementary EIS the Navy was required to file for the Pier D dredging project at PSNSY included extensive sediment sampling. Data from the shipyard's IR program were considered for the EIS, but could not be substituted for the testing because different sampling and analytical methods were used and the spatial coverage was deemed inadequate to meet dredging requirements. About 50% (by volume) of the tested sediments were suitable for disposal in Elliot Bay. The other 50% were designated for upland disposal at a sanitary landfill.

A brief delay in the Pier D dredging permit process arose when the Department of Ecology concluded that the project's goal was to remediate. The department was concerned that dredging up contaminated sediments would expose and re-contaminate clean sediments. This issue was resolved when the shipyard explained that the project was not a remediation effort and acknowledged that

some re-contamination might occur from propeller action near the very silty and mobile sediments. However, the issue of re-contamination might come up again for other dredging projects and for sediment remediation under IR. Because this project had high visibility because of the urgency of the AOE arrival in November, the permit application received high priority and the U.S. Navy was able to ensure that dredging started and was completed as scheduled.

Norfolk Naval Shipyard performs maintenance dredging approximately once every 5 years. The shipyard dredged about 200,000 cubic yards of sediment to maintain the dry-docks and pier berths during the first few months of 1995. This sediment was disposed on Craney Island. There are tentative plans to dredge another few hundred thousand cubic yards of sediment for a deepening project to accommodate aircraft carriers at the shipyard. There is, however, a potential problem associated with this effort because the dredged material disposal facility at Craney Island is near capacity. Closure of the Craney Island site will affect all dredging permittees in the Norfolk vicinity. Many options for disposal are under consideration, including a regional landfill site in Suffolk County. The latest consensus is that "clean" sediments would no longer be disposed at Craney Island beginning in 1997—only contaminated sediments could still be disposed there. If this becomes policy, the shipyard might continue to deposit dredged sediments, which the State testing program shows to be contaminated, at Craney Island. With respect to coordination between programs, the data generated for dredged material testing have been used to help determine sources of dry-dock contaminants under the NPDES program.

Pearl Harbor also performs maintenance dredging about once every 5 years, the last time in 1990. There are plans to do some dredging this year at the naval station, but no immediate plans to dredge at the shipyard. The 1990 general permit for dredging (testing was only required to get the permit and not before each operation) was revoked by the ACoE when the Pearl Harbor Naval Complex was listed on the NPL. During the NRaD site visit, the dredging permit renewal was in process. The permit was re-authorized for 5 years in December 1994, with a new requirement to do testing before each dredging operation in accordance with the Green Book and the State of Hawaii's guidance manual, the Interim Regional Implementation Manual.

ANALYSIS OF DREDGING PROGRAM REQUIREMENTS

All shipyards, with the exception of Norfolk, must perform some type of environmental testing before dredging and disposing of sediments. The Green Book procedures are followed for ocean disposal. The Inland Testing Manual (discussed later in this section) for the testing of materials to be discharged into inland or near coastal waters is available in draft form. The tiered-testing approach specified by the Green Book progresses from physical to chemical and, finally, biological measurements to determine suitability for ocean disposal. Specifically, the permittee must proceed from simple tests to more complicated tests until enough information is obtained to determine compliance or noncompliance with the Limiting Permissible Concentration (LPC). The LPC is equivalent to either the appropriate water quality criteria for the contaminants of concern (COC) or a toxicity threshold of the elutriate equal to 1% of the acutely toxic concentration.

The tiered approach addresses the two major contaminant pathways—the water column and benthic environments. Under Tier I, COCs are first determined from historical records and other information. Physical measurements performed on sediment can include grain size, total solids, and specific gravity. A basic premise of Tier I is that sandy or larger grain material does not adsorb contaminants and should pose no problem if the LPC is met. Chemical analyses are performed for the COCs in the water column. Using a numerical mixing model and a mathematical formula to calculate the Theoretical Bioaccumulation Potential (TBP), the water column dissolved concentrations are

compared with applicable water quality criteria in Tier II. If the WQC are violated, elutriate toxicity bioassays must be performed. Tier III determines the chemical concentrations adsorbed to dissolved matter in the water column, and acute toxicity, with suspended particulate phase bioassays. Tier III also directs acute toxicity bioassays and bioaccumulation tests on whole sediment (solid phase) to assess effects on benthic organisms. In rare cases where Tier III testing yields uncertain results, more toxicity and bioaccumulation testing may be directed under Tier IV (USEPA and USACoE, 1991).

Pearl Harbor's Interim Guidance Manual supplements the Green Book by defining the sampling, testing, and reporting requirements for dredged material proposed for ocean disposal at the five Hawaiian, EPA-designated Ocean Dredged Material Disposal Sites. The manual considers State-specific concerns such as chemicals of concern and indigenous species suitable for bioassays (USACoE and USEPA, 1994).

There is a difference between how sediments are tested for ocean disposal under the MPRSA and how they are tested for discharge into inland waters under Section 404 of the Clean Water Act. In the former, concentrations of chemicals in sediment must be compared to a relatively "clean" reference site. In the latter, the chemical concentrations are only compared to the concentrations existing at the disposal site. Therefore, for in-bay disposal sites that receive repetitive discharges, the comparison criteria may continue to become more relaxed as concentrations increase *in situ* over time. EPA recently proposed new regulations (December 1994) that would bring the inland testing procedures in line with the ocean testing ones. The significance of these changes, if implemented, is that in-bay sites, such as the one used in Puget Sound, might become more difficult to use. If upland disposal is required, this could mean higher compliance costs. The Inland Testing Manual has not yet been finalized because of this reference sediment issue (USEPA, 1995). However, in draft form, the manual is compatible with the Green Book, uses the same tiered approach, and has further built on the lessons learned since 1991 to provide guidance that is more detailed.

CONCLUSIONS AND RECOMMENDATIONS

The testing required for dredging is different than that required by other regulatory programs because the goal is to protect the ultimate disposal site rather than the excavation site. The reason dredging is important from an integrated compliance perspective is that the testing includes measurements of the same sediments adjacent to shipyards that are measured for other purposes under other regulatory programs. There is a potential for integration of sampling, analysis, and data reduction. Finally, the testing of sediments to be dredged at these locations might expose areas of contamination that might quickly become an issue of concern to local regulators and negatively affect the shipyard's IR program.

NRaD is currently conducting research to help the U.S. Navy deal with the harder problem of assessment and remediation of contaminated sediments. Screening techniques for sediment assessment might provide a rapid means to discriminate between clean and contaminated sediments. This geographical mapping of the sediments could focus dredging so that a smaller volume of the contaminated sediments would require handling and treatment.

- Dredging plan costs could be reduced if sediment testing data from NPDES and IR programs could be used. In most cases, the location of the sampling sites would be very close. Likewise, data from past dredging operations such as chemical concentrations, grain size characterization, toxicity, currents, and sediment transport could be used to assess sites of interest to other shipyard programs.

- Shipyards should work with the regulators to use some innovative approaches for sediment assessment, such as rapid *in situ* screening to support precise dredging. This would support two of the three scientific needs determined by the national working group (overcoming barriers and volume reduction).
- A tiered strategy approach, like the one used under Green Book procedures, could be considered for cost-effective execution of ecological risk assessment.
- Likewise, methodologies from ecological risk assessment, implemented under this integrated program for shipyards, could be used to support dredging programs. This idea is conceptually supported by the interagency report and might be successful in addressing the bioaccumulation issue (the third scientific need from the national report).

8. OTHER REGULATORY PROGRAMS

PROCESSING OF INDUSTRIAL AND OILY WASTEWATER

Introduction

Waste treatment at the naval shipyards has traditionally focused on the large volumes of industrial and oily wastewater generated by these facilities. Interestingly, as the amount of process effluents is decreasing at the shipyards, the regulation of these discharges is increasing. The shipyards are making modifications to their treatment plants to reduce metals and oil from the waste stream to comply with the increasingly stringent regulations.

Overview of Programs

Waste Treatment. Most waste that is sent to industrial waste treatment plants (IWTPs) is generated from shore-based activities: acids and solvents from painting and plating processes, and cleaners and solvents from various shops. Wastes that are heavily contaminated are typically combined with similar wastes and treated in large batches. The batch treatment removes the solids, neutralizes the wastes by adding chemicals, polymers, and flocculants, and then filters the waste. This batch treatment takes several days before the waste is discharged into a continuous flow system.

Continuous flow systems process two kinds of waste: (1) treated effluent from batch waste, and (2) waste that is less contaminated than batch waste, but generated routinely. Most continuous flow systems include a dissolved air flotation (DAF) tank that removes most of the remaining solids and separates the oils from the wastewater. This process is generally monitored to verify that treatment is successful.

Most oily wastewater generated at naval shipyards is bilge and ballast water collected from vessels docked at the piers or dry-docks. The waste oil rafts (donuts) that naval facilities have used in the past to collect and separate oily wastewater from vessels are being replaced. They are known to release oil into the marine environment. The replacement systems include the NFESC-developed Bilge and Oily Wastewater Treatment System (BOWTS) used at LBNSY, commercial products such as the Jalberts® system used at PSNSY, and other oily waste treatment plants (OWTPs). These treatment systems can remove metals and oils to the low ppm level. They typically use a combination of separators, skimmers, polymers, chemicals, and filters to clarify the wastewater. The concentrated oil (free product) is removed from the wastewater and recycled by a local contractor. On-site oily waste treatment systems at the shipyards have reduced the cost of treatment and disposal compared to using outside contractors (Harlowe and Torres, 1995).

The sludge generated from industrial and oily waste processing is sent to a filter press. It is condensed, dried, packaged, and sent to a landfill, if suitable, or a hazardous waste disposal facility if not.

Processing of Treated Effluents. With the exception of NNSY, where treated oily and industrial wastes are discharged directly into the Elizabeth River under the shipyard's NPDES permit, treated effluents at the other shipyards are discharged to a nearby POTW under pre-treatment permits. The POTW provides final treatment of the wastewater. The POTW servicing each shipyard assigns treatment limits and monitoring requirements for specific parameters. Industrial and oily wastes both contain dissolved metals in concentrations that require treatment. Chemicals are added at the shipyards to precipitate these metals out of solution. The precipitated metals are then removed by filtra-

tion. Currently, the federal discharge limits for metals at the shipyards are in the 1- to 10-ppm range, with the exception of cadmium. The effluent limits at each shipyard are based on national EPA standards, local limits, and the best professional judgment (BPJ) of the permit writer.

Shipyards appear to meet current regulatory limits for metals and oils discharged from their respective waste streams. However, regulators are beginning to apply limits that are more conservative, and this is adding to the cost of treating and testing these wastes. Proposed limits, the Metal Products and Machinery (MP&M) Effluent Limitations, have been established from best practicable control technologies (BPT). These new regulations will be published in 1996 as national guidelines for pre-treatment standards and waste treatment facilities (Bureau of National Affairs, 1994c). Phase I of these Metal Products and Machinery (MP&M) Effluent Limitations (USEPA, 1995c), applies specifically to industrial sites engaged in the manufacturing, maintaining, or rebuilding of finished metal parts, products, or machines. However, Phase II, which will regulate shipyards, will be promulgated approximately 3 years after Phase I. The current metal finishing regulations are less stringent than the proposed regulations, which would require some shipyards to make changes in their treatment operations. Furthermore, the proposed regulations, with the exception of chromium, are all higher than Federal Marine Acute Water Quality Criteria. These future regulations are in the low ppm to up upper ppb range. Table 9 shows these limits.

Analysis of Specific Program Elements

Long Beach Naval Shipyard, unlike the other shipyards, pumps all dry-dock process and wastewater into separate Baker tanks. Based on the test results of screening analyses performed by the IWTP, the water is either discharged into the sanitary sewer, sent to the IWTP for treatment, or disposed of as hazardous waste. When feasible, the discharge of wastewater directly into the sewer eliminates the need to transport and treat the effluent at Long Beach.

LBNSY processes 5 million gallons of oily wastewater per year in their OWTP. The concentration of oil in the treated wastewater discharged to the sewer must be <10 ppm. While the shipyard has had no problems meeting this limit, they have had difficulty meeting the POTW's pre-treatment standards for heavy metals in wastewater. To meet this limit, the shipyard has had to install a BOWTS. This treatment plant was designed to remove metals such as copper and zinc down to 0.02 ppm (Harlowe and Torres, 1995). This system should enable the shipyard to meet the pre-treatment limits when this system is operational.

The OWTP at PNSY processes 350,000 gallons annually and meets all of the pre-treatment requirements before discharge to the local POTW. Currently, both grey and bilge waters were being pumped from dry-docks into a railcar system. The Portsmouth IWTP has not been in operation since 1992 and is scheduled for closure.

Puget Sound Naval Shipyard has a Standard Operating Procedure (SOP) that specifies that all oily wastewater from a vessel bilge and ballast must be treated before discharge (Puget Sound, 1995). This treatment is directed by the EPA, and the guidelines are written within the NPDES permit. The shipyard annually treats 27 million gallons of oily waste with four Jalbert® Oily Waste Treatment Systems (OWTS). These systems reduce the oil and grease in the wastewater to <5 ppm, and reduce metals to 0.1 ppm. All treated effluent is discharged to POTW.

Table 9. Comparison of proposed effluent limits with current metal finishing regulations and Federal Water Quality Criteria.

Pollutant or Pollutant Parameter	Proposed Daily Maximum (mg/L)	Proposed Monthly Average (mg/L)	Current Metal Finishing Regulations (mg/L)	Federal Marine Acute Water Quality Criteria (mg/L)
Conventional Pollutants				
Oil and Grease	35	17	-	Narrative
TSS	73	36	-	Narrative
PH	6 to 9	6 to 9	-	6.5 to 8.5 (Federal Chronic)
Priority and Non-Conventional Pollutants				
Aluminum (Al)	1.4	1.0	-	0.750 (Freshwater)
Cadmium (Cd)	0.7	0.3	.69	0.0430
Chromium (Cr)	0.3	0.2	2.77	1.1000
Copper (Cu)	1.3	0.6	3.38	0.0029
Cyanide (Cn)	0.03	0.02	1.20	0.0010
Iron (Fe)	2.4	1.3	-	-
Nickel (Ni)	1.1	0.5	3.98	.07500
Zinc (Zn)	0.8	0.4	2.61	.09500

Norfolk Naval Shipyard treats approximately 8 million gallons of oily wastewater annually, using pierside DAF units. The discharge regulatory limits are taken directly from the effluent guidelines for metal plating facilities, which are more lenient than NPDES limits. The shipyard is meeting the pre-treatment standards of their permit. The IWTP has been successfully treating all metals to <100 ppb, often reaching to levels <50 ppb. The shipyard is preparing an environmental protection manual that specifically addresses all sampling activities at the shipyard. All treated wastewater from NNSY is discharged into the sanitary sewer.

Pearl Harbor treats approximately 1 million gallons of oily wastewater annually with three semi-mobile systems. The systems reduce oils to <15 ppm, often achieving 5-ppm levels. The shipyard's limit for oily wastes discharged to the POTW is 25 ppm. In addition, the shipyard analyzes six different metals in the effluent. None have exceeded discharge limits. At the IWTP, there is no oily water treatment capability (no gravity separation) and the plant has difficulty treating metals. Specifically, the plant has had trouble with the chelating agents it uses to treat silver. Additionally, the plant does not have a continuous flow capability. A Military Construction Project (MILCON) is planned for 1996 that will build a new IWTP for the entire naval complex. This plant will treat regional DoD waste. All treated effluent from PHNSY is discharged to the POTW.

Recommendations

- To resolve NPDES compliance problems, the shipyards might need to consider treating dry-dock process wastewaters in their waste treatment process; Long Beach might serve s a model.
- All shipyards should establish SOPs for sampling activities like those under development by NNSY and PSNSY.
- Shipyard IWTPs and OWTPs should be aware of the proposed new rules for the MP&M industry relating to waste treatment.

OIL AND HAZARDOUS SUBSTANCES RESPONSE

Introduction

The Exxon Valdez catastrophe in 1989 prompted the U.S. Congress to write new legislation to simplify and improve oil spill responses. Different sections of the Code of Federal Regulations had to be rewritten to implement these mandates. The Oil Pollution Act of 1990 (OPA 90) amended Section 311 of the CWA, the National Contingency Plan (NCP), and gave the Federal government responsibility for directing all public and private spill response efforts. OPA 90 enacted requirements to prepare Facility Response Plans in addition to the previously required Spill Prevention, Control, and Countermeasure (SPCC) plans, used as a management tool for a facility to document its own spill response measures. These new response plans must address onshore, non-transportation facilities that have oil storage capacity above certain thresholds, regulated by the EPA. They must also address offshore marine transportation-related facilities that are regulated by the United States Coast Guard (USCG.) All Facility Response Plans require planning for a worst case spill at every facility and the consideration of sensitive ecological areas. Because the mandates of OPA 90 are so broad and ambitious, the process of implementing the OPA is still ongoing (Riley, 1994). Under CNO policy, all U.S. Navy shore facilities must develop a Facility Response Plan in accordance with OPA 90 (Department of the Navy, 1994).

Overview of Response Plans

Because the regulations under OPA 90 are new, the shipyards are still writing facility response plans that will be reviewed by EPA and the USCG. Some facilities are confused as to which regulations apply. Any facility that "could reasonably be expected to cause substantial harm to the environment by discharging into or on the navigable waters or adjoining shorelines" is required to submit a facility response plan (USEPA, 1994e). Several screening criteria establish if a facility is categorized this way. Under OPA 90, all of the shipyards must submit a facility-specific response plan to EPA and USCG. The response plans required by OPA 90 must provide a plan of action to protect environmentally sensitive areas and strategies commensurate with regional area contingency plans.

OPA 90 requires that response plans be consistent with the National Oil and Hazardous Substances (OHS) Pollution Contingency Plan (NCP) and any applicable Area Contingency Plans. To prepare for an unexpected OHS spill, the plans must "assess the possible hazards to human health and the environment due to release." Several environmental factors must be considered within these response plans, including proximity of a facility to fish, wildlife, sensitive environments, and other areas determined to possess ecological value. In addition, site-specific characteristics and environmental factors that are relevant to protecting the environment from harm by discharges of oil must be considered, including drainage patterns, annual rainfall amounts, and tidal activity.

The Long Beach and Puget Sound Naval Shipyards have the most detailed and comprehensive response plans, each consisting of 100 or more pages with numerous tables and graphs for reference. Puget Sound's plan has a detailed discussion on marine resources at risk after a catastrophic oil spill, and with the natural resource trustees, they have identified specific areas and responses. The EPA, USCG, and Washington State regulators have all reviewed and approved the Puget Sound Response plans. Long Beach's plan has a more general discussion of resources at risk, but explains some practical response measures that would protect these marine habitats in case of a spill. Portsmouth Naval Shipyard's plan briefly addresses sensitive areas of ecological concern, and has approval from the EPA and USCG. When NRaD visited PNSY in the summer of 1994, there were plans to develop hydrodynamic modeling techniques to aid in oil-spill response assessment. Because of tidal effects in the Piscataqua River, EPA requires modeling of the impact of a spill 15 miles upstream and downstream from the shipyard. NNSY does not have a facility response plan and is not required to develop one. Norfolk does have a SPCC plan. PHNSY does not have any discussion of sensitive areas of ecological concern in their SPCC plan or facility response plan that should be considered. Although Pearl Harbor is mostly industrialized and there are not many resources on the base, the adjacent aquatic resources and sensitive areas within the entire harbor must be protected if an oil or hazardous substance release occurs.

To meet the requirement for assessing possible hazards to the environment from an oil or hazardous substance spill, it would be beneficial for each shipyard to have a detailed discussion of marine resources at risk and practical measures of response to protect these ecological resources if a spill occurs. For maximum benefit under an integrated approach to marine environmental compliance, information in this section of the facility plan should be coordinated with Natural Resources Management Plans and ecological risk assessments performed within the IR program.

Finally, there is an opportunity for shipyards to stay ahead of the regulators in this programmatic area of spill response. Removal of oil sheen does not necessarily eliminate dissolved components of oil spills. This dissolved fraction can contain toxic compounds such as polycyclic aromatic hydrocarbons (PAHs). Although there appears to be no specific requirement under OPA 90, monitoring the water column after an oil spill can assist managers in predicting the fate and transport of these toxic pollutants. Understanding the movement of oil spills will enable facilities to prepare better response plans for an emergency. As demonstrated by the PNSY requirement to model for the worst case scenario, hydrodynamic modeling of an oil spill plume might eventually be required at other locations.

Recommendations and Conclusions

Any moderate or severe spill could harm aquatic biota inhabiting the affected waters. Knowledge of the status and health of the ecological environment before any such spill occurs will aid in the assessment of impacts once it occurs. Methods for monitoring chemical and ecological parameters instituted at shipyards under this integrated program would enable the U.S. Navy to rapidly, accurately, and cost-

effectively assess these potential impacts. Consequently, a coordi- nation among affected regulatory programs is recommended: oil and hazardous substance spill response, natural resources management, and ecological risk assessment (administered under IR programs). Finally, innovative hydrodynamic fate and transport modeling techniques developed for NPDES or Ecological Risk Assessment could be used along with oil and hazardous substance response.

- Norfolk NSY should add to their current SPCC plan to develop a Oil and Hazardous Substances Facility Response Plan as required by OPA 90 and mandated by CNO policy. This plan should include a section describing sensitive ecological areas.
- PHNSY should modify their facility response plan to develop a description of the regional ecological resources at risk and the protection measures that should be taken in if oil or hazardous substance is released.
- Facility Response Plans should have detailed discussions of marine resources at risk and include practical measures of response to protect these ecological resources if a release occurs.
- Shipyards should coordinate development of OHS Response Plans with Natural Resources Management Plans and Ecological Risk Assessments.
- Hydrodynamic models for predicting fate and transport of oil spill plumes should be developed, validated, and included in the plans.
- Shipyards should be proactive with these plans by developing chemical and ecological monitoring plans to be implemented in case of an oil spill.

NATURAL RESOURCES PROGRAMS

Introduction

The primary goal of an installation's Natural Resources Program is to develop a 5-year planning document to guide legally and ecologically sound, cost-effective management of the natural resources surrounding the shipyard. There are several statutes to which these programs must conform, but the U.S. Navy's overarching guidance can be found in OPNAVINST 5090.1B, the Navy's Environmental and Natural Resources Program Manual. Unlike most of the other regulatory programs, there is very little scrutiny concerning the development or daily enforcement of these plans. Nevertheless, the management of natural resources, especially of ecosystems, is directly related to the establishment of an integrated approach to marine environmental compliance at naval shipyards. There are many areas of overlap between natural resources management and the regulatory requirements of other programs, such as Oil and Hazardous Substance Spill Response and Installation Restoration's ecological risk assessments.

Overview of Resource Management Plans

Long Beach Naval Shipyard has the most detailed and practical Natural Resources Manage-ment Plan (NRMP) of the shipyards surveyed. The "Final Natural Resources Management Plan" (EFD Southwestern, 1994) is an excellent example of a comprehensive planning and management document. It provides guidance for the maintenance of the facility's natural resources and includes a detailed biological inventory. It also addresses issues of ecological concern, makes management recommendations, and suggests practical methods to protect, assist, and develop ecological habitats and communities. The plan further addresses sensitive environments and endangered and threatened species.

Portsmouth Naval Shipyard's NRMP (EFD Northern, 1993) is an extensive and practical management plan for natural resources. Like the LBNSY plan, it has the standard biological resource inventory, but it also details management measures for the preservation and development of ecological habitats.

The NRMP prepared by PSNSY (EFA Northwestern, 1994b) has a detailed inventory of biological resources and the elements of a practical management plan. Some recommendations for protecting ecological habitats are specific and others are more general. However, one important aspect of this plan is that the recommendations are all summarized and ranked with one of three priority classifications. This allows effective use of personnel and financial resources to fix the most urgent problems first.

Norfolk's "Land Management Plan" (EFD Atlantic, 1991) provides background information of the shipyard's natural resources, discussing the existing environment, terrestrial maintenance, and protection of ecological habitats. While some recommendations are presented, they are expressed more as possibilities for natural resource improvement than as measures for implementation. There is a limited inventory of biological resources consisting of a listing of flora, but not fauna.

Pearl Harbor's NRMP (EFD Pacific, 1990) is represented by their "Cooperative Agreement for the Protection, Development, and Management of Fish and Wildlife Resources at Naval Base, Pearl Harbor." This document primarily provides instruction to facility personnel regarding compliance with applicable State and federal regulations to protect, develop, and manage the fish and wildlife resources at the naval complex. There is a brief summary description of the ecosystem, but no inventory or listing of biological resources. No practical management measures for the ecological protection or development are discussed. It is important to address all of the aquatic resources outside the area of the shipyard that might be affected by any oil or hazardous substance release into the environment.

Elements of individual plans should be modified and adopted for other shipyards. All shipyards should attempt to assess the health of their aquatic ecosystems at the same level of detail as is provided for their terrestrial resources. An accurate and detailed plan can provide a baseline to assess any future ecological impacts. Additionally, the plans should have specific management measures for protection and development of ecological habitats, and these measures should be prioritized. Finally, it will be necessary to coordinate development and refinement of NRMPs with other regulatory programs such as Oil and Hazardous Substance Spill Response and Installation Restoration. This coordination will ease compliance within an integrated approach.

Recommendations and Conclusions

A Shipyard's Natural Resources Management Plan could be the one comprehensive document that guides the assessment, protection, and enhancement of aquatic ecosystems adjacent to the facility. Ecological risk assessment to manage aquatic resources under this integrated approach to marine environmental compliance is a logical extension of a facility's NRMP.

- An accurate and detailed NRMP can provide a baseline to assess any future ecological impacts.
- Shipyards should attempt to assess the health of their aquatic ecosystems at the same level of detail as is provided for their terrestrial resources.
- NRMPs should have specific management measures for protection and development of ecological habitats, and these measures should be prioritized.

- An accurate and detailed NRMP can provide a baseline to assess any future ecological impacts.
- Shipyards should attempt to assess the health of their aquatic ecosystems at the same level of detail as is provided for their terrestrial resources.
- NRMPs should have specific management measures for protection and development of ecological habitats, and these measures should be prioritized.
- A comprehensive and practical NRMP will ease compliance with other regulatory programs such as the Oil and Hazardous Substance Response Plans and Installation Restoration.
- The other shipyards should review the NRMPs for Long Beach and Portsmouth as potential models for their own plans.

9. ENVIRONMENTAL INFORMATION MANAGEMENT

INTRODUCTION

Information is the primary product of the Shipyard Environmental Divisions, and measurement data are the basic raw material of those products. Division personnel gather, either directly or through contracts, quantitative and qualitative observations about the shipyard environments. They augment these measurements with information from environmental regulations and directives, monitoring permits, assessment reports, the scientific and technical literature, and other sources. The staff adds value to these information sources through their analysis of the patterns they contain, their interpretation of the environmental processes they represent, and their recommendations for protecting the natural environment while supporting the shipyard's mission.

Given the importance of accurate, detailed, and timely information, modern information management systems are as critical to the success of the Environmental Divisions' programs as the analytical, abatement, remediation, and other technologies they use. Unfortunately, two factors have obscured this requirement. First, the collection and processing of environmental information is fragmented among different programs, at the shipyards and among the regulatory agencies. Second, the few regulatory directives governing the management and stewardship of environmental data are sporadically enforced. Consequently, environmental information management at the shipyards is largely a manual, paper-based, and marginal activity.

This section outlines the proposed requirements for the shipyards to develop an integrated environmental data management policy and adopt modern electronic data management systems. At the core is the requirement that the division staffs have at their disposal the ***primary measurement data*** generated by environmental monitoring and assessment programs at the shipyards. Next to the accuracy and precision of the primary measurements themselves, the most important quality factors are to ensure that the measurements are ***fully documented*** and are available in ***digital form***. These factors are essential for organizing the data into an integrated database that can support diverse applications, now and in the future.

Having the shipyards' primary measurement data in an integrated database is an essential prerequisite to a risk-based environmental compliance program. It is also the most cost-effective use of these data. The shipyards can no longer afford the one-time use of environmental measurements. The cost of field measurements must be amortized by sharing them with other programs that need similar data. Sharing data not only reduces the up-front sampling and analytical costs; accumulated observations eventually provide broader and more accurate spatial and temporal perspectives of the shipyard's environments. These perspectives are essential to the understanding of environmental changes that are occurring at the shipyards. The objectives of sharing data between programs, accumulating data over long periods of time, and viewing data from different perspectives can best be accomplished if the data are primary (original), fully documented, and organized into an electronic database.

This section divides information management into three related topics: the ***data*** generated by environmental measurements and associated activities; ***systems*** used to manage these data; and the hardware, software, communications and other elements of the ***electronic infrastructure*** needed to support environmental data management.

The other sections in this report begin with an analysis of existing programs. Because there are no active environmental data programs at any shipyard, this section provides more discussion of

recommendations for establishing information management policy, procedures, and systems and less to an analysis of existing programs.

MEASUREMENT AND SUPPORTING DATA

Background

Changes in the structure and function of natural ecosystems have turnover rates of decades. That is, given some stress or other factor that is driving the ecosystem towards a new endpoint, the effects of that stress on the species composition, abundance, and material cycles of the ecosystem might not be apparent "to the naked eye" for 10 to 20 years. Detecting these changes therefore requires observations of the environment that are on comparable time scales. Environmental processes also extend beyond the geopolitical boundaries of the regulatory and regulated organizations. For a shipyard, understanding these processes requires a spatial perspective that includes the entire water body in which the shipyard is located, the surrounding watershed, and adjacent offshore regions. While society may view environmental status in terms of human health or the well being of important biological species, the shipyards must also understand the physical and chemical processes that govern the fate and effect of materials released into the environment. Understanding environmental processes requires data from many disciplines collected over a long period and a broad geographic region.

Because the shipyards (or any other agency) lack the resources to gather environmental information on these scales, they must accumulate and combine measurement data from narrower studies. Of the various types of information the Environmental Divisions need to process digitally, measurement data are possibly the most important to their general mission. These data can come from different programs at the shipyards: IR, NPDES, and Natural Resources. They may be collected by shipyard, or by contract personnel as part of one-time assessment or ongoing monitoring studies. The measurement data might include biological, chemical, or physical parameters from marine, terrestrial, or atmospheric environments. They might even come from studies conducted by other organizations in other environments of interest to the shipyards.

Measurement data gathered by or for the shipyards should have the following attributes to be maximally useful.

Primary Measurements. The measurement data should include the basic field or laboratory data and corresponding units, not summary statistics (e.g., means and standard deviations) or other reduced numbers. Statistical or graphical summaries are useful in presenting information to the reader, but necessarily involve a loss of information and should be restricted from this category of data. Summaries also limit direct comparison of measurements from different studies and different perspectives of the data. Methods of summarizing data also change over time; unless the primary measurement data are stored, future summaries may be restricted or impossible.

Fully Documented Measurements. A measurement involves more than just the quantity and units. Fully documented measurements should include the supporting information regarding the location and time of the measurements, the person who made the measurements, the methods used to make the measurements, the analytical QA/QC data, and so forth. Associated **metadata**—supporting information such as why the measurements were made, how to obtain a copy of the data, and so forth—are also part of a completely documented measurement.

Digital Measurements. Future measurement data, supporting data, and metadata should be made available to the shipyards in digital form. Most measurements made today are either collected in

digital form or are transferred to digital form as part of the analysis and reporting process; Therefore, data analysts should provide the shipyards with the data in the form that they used. In addition, the shipyards and their contractors need to ensure that all the supporting information needed to document each primary measurement is available digitally.

Current Status

The environmental data gathered by and for the shipyards are generally not reported as primary measurements, incompletely documented, and available only in hardcopy form. Sometimes (e.g., the Administrative Record at LBNSY), the hardcopy documents are collected in a single location; more often, they are scattered among the offices of the Division or the regional NAVFAC Engineering Field Division.

Most measurement data included in these reports were gathered to support monitoring operations (as discussed in sections 4 and 5), IR studies (section 6), dredging (section 7), or natural resource studies (section 8). The primary measurement data reported in these hardcopy documents are typically recorded in tables scattered throughout the document text. The measurements are occasionally reported in separate tabular appendixes. Should it become necessary to extract these data from hardcopy reports, it will be faster, easier, and cheaper to scan and digitize data from separate tables than to extract them from the body of the document.

The two most notable exceptions to this pattern are the "offshore" data from the PNSY ecological risk assessment and the measurements captured in the shipyard Laboratory Information Management System (SLIMS). The primary measurement data from the PNSY risk assessment are fully documented and available in digital form. The original data from that project are recorded in ASCII data files and companion ASCII metadata files. Some of the same data are recorded in a computer database. The contractor for the "inshore" (terrestrial, freshwater, and groundwater) measurements now has these data available in a digital database.

More shipyards are writing digital data delivery requirements into their contracts for environmental studies. For example, the recently awarded RI/FS contract at the LBNSY specifies that data should be delivered by the contractor (Bechtel Corporation) in digital format. Mike Radecki reports that SWDIV has begun writing this requirement into all their environmental contracts. They further specify that the contractor must maintain these data in a digital format for 5 years after the termination of the contract. The U.S. Navy can request a copy of the digital files at any time during that period.

Recommendations

The foundation of an environmental information management system for the shipyards rests on three pillars:

- Ensuring that primary environmental measurements are reported in fully documented digital form;
- Organizing the measurement and supporting data into an integrated database;
- Providing the hardware, software, communications, and training to access and use the data.

The first critical precursor to this foundation is a ***data model*** from which the database design and the data reporting specification are developed. The second precursor is a ***data management plan*** that defines the procedures for specifying, receiving, verifying, and managing environmental measurement data. These two topics are discussed first because they apply to all of the specific recommendations that follow.

Data Model. Data modeling is a technique that is widely used for translating end-user requirements into a logical database structure. It provides the end-user and the database designer with a visual representation of the interaction of objects about which information must be stored (i.e., entities), the attributes of those objects, and the relationships between the objects. This understanding is vital to ensuring the database can store the requisite data, provide users with appropriate views of those data, and safeguard the quality of the data with appropriate integrity constraints. See Sanders (1995) for a more detailed discussion of data modeling techniques.

NRaD has undertaken the development of a generalized environmental data model to support the shipyards' information management requirements. This model will provide a framework for specifying, storing, and managing primary measurement data from diverse environmental studies and for diverse applications of the data. The core of the model will be derived from NRaD's more than two decades of experience in generating and managing environmental data. NRaD will use the model to present the organization of entities, attributes, and relationships in pictorial and tabular form. Both forms will be used to elicit further refinements to the model from Environmental Division staffs based their specific or unique information requirements. Two of the principal by-products NRaD will develop from the data model, the data reporting specification and the database definition, are discussed below.

Data Management Plan. The Data Management Plan (DMP) will provide guidance on the collection, evaluation, maintenance, and use of environmental data collected by or for the shipyards. Ideally, there will be one programmatic DMP for all the shipyards, and it can serve as a template for project-specific DMPs. The DMP will set forth the objectives for collecting the data and for organizing and structuring the data files. It will also outline the procedures and responsibilities for receiving and validating the data files, and the guidelines for controlling access and providing maintenance of the data.

Existing Data Sources. Each shipyard should organize a central library of their existing environmental reports. If possible, the hardcopy documents should be originals (as opposed to photocopies) and should include all supporting materials (appendices, photographs, maps, charts, and so forth). Ideally, a catalog of these documents should be prepared, preferably using a software package like ProCite (Personal Bibliographic Software, Inc.). NRaD personnel can help the shipyard staffs to organize such a catalog.

Where existing source materials have been delivered in digital form, the files should be transferred to 3.5-inch, high-density diskettes, properly labeled and stored in a suitable diskette holder in a cool, dry place. If not already available, each diskette should include an ASCII text README file that lists and describes the files it contains. Once all the files have been written to the diskette, the write-protect tab on the diskettes should be set to the read-only position.

The shipyards should contact contractors who did environmental studies for them in the past 5 years to ask the contractor if the information from those studies is still available in digital form. If it is, NRaD will help the shipyard staff decide what information is in digital form, how complete the digital information is, how the files are organized, and the cost to obtain copies of these materials.

Extracting Data From Existing Sources. Measurement and supporting data can be extracted from existing hardcopy sources by either of two methods: retype the data into a computer, or digitize the text on a scanner and convert it to computer files using optical character recognition (OCR) software. Both methods have their advantages and drawbacks. Retyping the data is more flexible; the human operator can make ad hoc decisions about the format and content of the documents that would be difficult to duplicate on a computer. On the other hand, because the work is slow and tedious, it is also expensive and error-prone. Digitizing documents on a scanner is relatively fast and cheap. However, the error-rate in converting the scanned images to text goes up rapidly if the quality of the original document is poor. Consequently, it may cost as much to have a human find and correct the text translation errors and to match information form different parts of the document as it would have been to pay someone to retype the data.

Because of the expense, data should not be extracted from hardcopy documents except as needed for a specific application. Then, the decision of whether to scan or key-enter the data from the documents must be made on a source-by-source basis. If the measurement data are organized in suitable tabular form, with a minimum of extraneous lines and characters, and if the print quality is sufficiently high, then scanning the document and using OCR software to extract the characters from the images is probably the preferred path. However, much of the supporting and associated data will still have to be key-entered. If the data must be key-entered, data entry screens ("forms") should be developed to ensure the data entry technicians obtain all of the relevant values. Extensive post-processing error checking will be required in either event.

Regardless of the extraction method, the shipyards should focus first on getting all of their source documents into a central, managed, and catalogued collection where they are accessible to the users who need them. The shipyards should also contact the authors of these studies to learn what information from the documents is still available in digital form. Extracting data from the source documents into digital form should be undertaken on as required.

New Data Sources. A major advantage of developing a data model and deriving a data reporting specification from it will be that it provides a mechanism to ensure all future data are fully documented and suitably formatted. Once these specifications are in place, all future measurement data and metadata generated for and by the shipyards' Environmental Divisions should be stored in digital form in standard formats. Environmental Division reports should be delivered in digital form. Except as dictated by U.S. Navy contracting policy, these documents need not conform to a standard format. The shipyards should try to store other types of documents, including correspondence (written and e-mail), instructions, and so forth, in digital form.

The Environmental Divisions should acquire and store reference materials in digital form. This would include environmental regulations, U.S. Navy policy directives, instrument user manuals, reference data, standards, and similar materials. They should digitize and store relevant hardcopy documents received in the future. Existing hard copy documents should be digitized on an as-needed basis.

An important first application of the shipyard database model (see below) will be to develop standards for reporting environmental measurement data and metadata. "Data reporting" is the presentation of the primary measurement data and supporting information, including metadata, in a separate tabular format. The purpose of the ***data reporting specification*** is to ensure that measurement data collected in the future (or extracted from existing reports) are fully documented and properly formatted for digital processing. Shipyard personnel can use these standards for in-house work and contract specifications.

The data reporting specification will not specify how or what to measure; scientists conducting the study will make those decisions. Rather, the specification will identify the types of information that are necessary to fully document a measurement (i.e., content). It will also specify how to organize and format the data for incorporation directly into a digital database. The specification will also address important procedural issues such as recording chain-of-custody information, establishing sampling hierarchies, and so forth.

NRaD is monitoring several national and international efforts to develop a reporting specification for environmental data. NRaD will adopt these specifications wherever feasible; otherwise, it will incorporate relevant elements of these standards into its data reporting specification. Most national and international efforts at data reporting standards (not necessarily environment data) are geared toward geospatial data managed by Geographic Information Systems (GIS). Some important standards include:

1. The Spatial Data Transfer Standard FIPS-173 (Federal Information Processing STandards, 1994), under development by the Federal Geographic Data Committee (FGDC) as part of their National Spatial Data Infrastructure (NSDI) initiative. The WWW page for the FGDC is:

   http://geochange.er.usgs.gov/pub/tools/metadata/standard/fgdc.html

   In addition, the text of FIPS-173 can be obtained in WordPerfect format from:.

   http://www.ncsl.nist.gov/fips/fip173.wp

2. The Tri-service Spatial Data Standard (TSSDS) is being prepared by the Tri-Service CADD/GIS Technology Center at the USAE Waterways Experiment Station in Vicksburg, MS. The TSSDS standard is following the FGDC standard. Further information about, and a copy of, the TSSDS is available on the WWW from:

   http://mr2.wes.army.mil/

3. The Navy Environmental Data Transfer Standards (NEDTS) are being developed by NAVFAC with much the same intent as TSSDS. These standards will govern the export/import of data from/to the Intergraph GIS systems NAVFAC is using. The point-of-contact for the NEDTS is Mr. Chris Kyburg at SWDIV;
   e-mail: cekyburg@efdswest.navfac.navy.mil

There are no generalized standards for environmental measurement data. Some significant efforts that are underway for environmental reporting standards include:

1. The Ecological Society of America's Future of Long-term Ecological Data (FLED) project. This project, which is attempting to identify and preserve long-term ecological records, is working on a "Data Documentation" specification for storing these data sets. The WWW address for the FLED project is:

   http://www.sdsc.edu/1/SDSC/Research/Comp_Bio/ESA/FLED/FLED.html

2. As part of its CLEAN II effort, SWDIV has adopted IT Corporation's Environmental Database Management System (ITEMS) as a central repository of environmental data for various installations. More information about CLEAN II is available from DoD's WWW Denix WWW server: http://129.229.1.100/denix/denix.html

   Note: A userid and password are required to access Denix beyond this top-level.

3. Mr. Bruce Gritton at the Monterey Bay Aquarium Research Institute (MBARI) has developed a substantial data model and supporting documentation for their oceanographic research studies. The WWW site for Bruce Gritton is as follows: http://www.cse.ucsc.edu:80/~grbr/

The issue of how to make environmental data more widely available is a topic of active interest among a broad spectrum of organizations connected to the Internet. The Center for Coastal Studies at (http://coast.ucsd.edu:80/) at Scripps Institute of Oceanography, the Environmental Research Information Network at the Australian National University (http://www.erin.gov.au/erin.html), and many others offer a wealth of ideas and practical information on this subject.

Another area of active interest in environmental documentation standards involves metadata. However, Content Standards for Geospatial Metadata of the Federal Geographic Data Committee (FGDC) is the only available option for use, again as part of the National Spatial Data Infrastructure (NSDI) initiative. The FGDC metadata standard is available from the following location:

http://geochange.er.usgs.gov/pub/tools/metadata/standard/metadata.html

The data reporting specification that NRaD is developing will address the issue of reporting Quality Assurance/Quality Control (QA/QC) data. In the past, regulatory agencies have set detection limits for analytical methods (e.g., Method Detection Limit or MDL). When the concentration of a pollutant in a sample is below the specified limit, the analyst will often report the value for that sample as "ND" (Not Detected). A character string like "ND" cannot be stored in a numeric data field. This forces the database administrator to decide whether to store the value as zero (0), which probably is not true, or to leave the field blank, which suggests no measurement was made and definitely is not true. If, however, the QA/QC data upon which the detection limit decision was based are stored along with the actual value from the analysis, then the user of the data can decide how much confidence to place in the value. Because methods of calculating environmentally significant detection limits change with time, storage of the measurement value and the QA/QC data permit re-evaluation of the measurements in light of these changes—something that is impossible when "ND" is reported.

The primary application of the data reporting specification will be to require it as an enclosure to contract SOWs. The shipyards can use the specification before measurements are made to ensure that field and laboratory procedures capture all the essential supporting information and that the measurement and supporting data are reported in suitable format.

A secondary application for the data specification will be to guide the extraction of data from reports and data sources. The person extracting the data can use the specification to know what type of information to look for, or to guide questions of original investigators who are still available.

Although most of the shipyards' existing environmental reports were delivered in hard copy, the documents may still be available in digital form elsewhere. Any reports prepared in the past 10 years were probably created with a word processor. Moreover, most of the analytical laboratories used in these studies employ an automated LIMS. The digital files might not have been saved in some cases by the contractors who prepared them. It will not always be clear who "owns" these older digital documents and what the contractor might charge the shipyard for a copy of a file. Still, it might be more cost-effective and less error-prone to pay for a digital copy of an existing data file than to try to recreate it digitally from a hardcopy document.

DATA MANAGEMENT SYSTEMS

Background

Capturing fully documented primary measurement data in digital form is a necessary, but not a sufficient prerequisite to making multiple use of the data. The organization of the data must allow users (people and application programs) to: (1) start with different perspectives and still find the data, (2) combine data from various studies, and (3) reorganize data into a format that is most useful for on-screen viewing, reports or graphs, or manipulation in a spreadsheet or statistical program. These functions are provided by software applications known as database management system (DBMS).

A database is a shared collection of logically related data designed to meet the information needs of multiple users. In its simplest form, a digital database could be a file in which the data values are recorded in text form. At a somewhat more complex level, a database could be a computer spreadsheet in which the data are stored internally as columns of text, numbers, and dates. In the discussions that follow, a database includes any collection of data managed by a formal DBMS.

A DBMS is software (sometimes software plus hardware) that creates, maintains, and provides controlled access to data in digital form. DBMSs can range in complexity from a desktop application such as Access (Microsoft® Corporation), running on a PC and costing a few hundred dollars, to a product like Oracle® (Oracle Corporation) costing hundreds of thousands of dollars and running on a mainframe computer. Access and Oracle are examples of a widely used class of DBMSs, those based on the relational data model and known as relational database management systems (RDBMS) (Date, 1995).

Data are organized in an RDBMS into tabular structures known as "entities" (often simply referred to as "tables") and linkages between entities known as "relationships." A well-developed relational algebra and relational calculus exists for organizing and accessing However, to take advantage of this power, the database must be organized according to the formalisms of relational database design. Because easy-to-use graphical interfaces have made the basic features of an RDBMS available to end-users without having to follow these formalisms, RDBMSs are often used to store information in simplistic "flat-file" structures. This type of organization may suffice for the individual user with limited applications for the data. If different people and different applications over an extended time use the data, the lack of a rigorous database design will become apparent in several areas:

Data Currency. A primary objective of a DBMS is to prevent redundant information storage. Redundant storage is a problem because if the information is stored more than once, one of those values can become out-of-date. If, for example, a person's address is stored twice and the person moves, the address must be updated in both locations. Updating only one of these addresses means the other one is now out-of-date. The path the user takes will determine whether they retrieve the current or outdated address. Moreover, it may be impossible for the user to tell whether the value returned is the current or the out-of-date value. On the other hand, storing an address in only one location in the database and using relationships to link the addresses to entities that need them—people, organizations, events, an so forth—makes it possible to maintain data currency.

Data Integrity. Without a rigorous definition of the entities and the relationships between them, the RDBMS cannot ensure the integrity of data when records are added, removed, updated, or retrieved. For example, suppose a table is created in an environmental database to record the people who participated in a field survey. Besides the person's name, the table might record the name of the organization the person worked for and the organization's address. If the survey is removed from the database at some point, not only is the knowledge of who worked on the survey lost—which may be

acceptable—but the organization's address may also be lost, which probably is not an acceptable consequence.

Data Independence. DBMSs were developed largely to separate the logical view of data, as seen by a computer program or a person sitting at a computer monitor, from the physical representation of the data in the computer. While this separation has always been important, it is vital in today's world of connectivity between applications across networks. A table that appears in a modern word processing document might, in reality, be a "hot link" to a database half a continent away. Without data independence, reorganizing the database for better performance can invalidate all the applications that are using the data it contains.

Performance. A rigorously defined DBMS can enhance performance by reducing the redundant storage of data, optimizing data retrieval, and by "caching" the most recently accessed records.

Current Status

Because few of the shipyards' environmental data are in digital form, almost none of these data are stored in an integrated database. Again, the two exceptions to this pattern are the "offshore" risk-assessment data from PNSY and the analytical database attached to SLIMS.

The PNSY offshore data are organized into two databases. One database records measurements from samples collected during Phase I of the project and sent to outside laboratories for analysis. The staff of EPA's ERLN facility in Narragansett, RI, maintains this database. The RDBMS for this database is Oracle Version 7. The database is stored on a VAX/VMS computer at the EPA's data center in Research Triangle Park, NC. A second database, containing other data from Phase I and new data from Phase II, was developed using Microsoft's Access® RDBMS. This database, which is resident on a PC at the ERLN, makes it is easier for the scientists to enter and manipulate the data on their own. Access also provides a more convenient interface to the statistical and graphical applications the scientists are using. Eventually, the Access® database, the ASCII source files from which it was generated, and the supporting metadata will be installed on a server computer on the PNSY Local Area Net (LAN).

The original version of SLIMS was fielded at PSNSY in 1988. This version consisted of a Hewlett Packard® HP-1000 minicomputer, running the RTE-A operating system and HP's commercial laboratory information system software, LAB-SAM. A second A900 or A400 computer served as a data acquisition system for LAB-SAM and was connected to the HP-1000 through an intra-laboratory LAN[7]. This configuration was eventually installed at the remaining four shipyard laboratories.

Hewlett Packard® was contracted, originally by PSNSY, to connect the analytical instruments at the shipyard laboratory LAB-SAM. They analyzed the output from each instrument and developed automated and manual procedures to read and extract the data from the files generated by the instruments. Problems were encountered with the software drivers for the various instruments, and with the mechanisms the different instruments used to pass data through their data port. Once the instruments exported the data, there also were problems organizing the data in the LAB-SAM database. In particular, when analyses for some analytes were done on one instrument and those of other analytes on another instrument, the database could not match the measurements from different instruments. Overcoming this deficiency in the LAB-SAM data structures required a fair amount of programming by the SLIMS staff, as did problems encountered with the specification table look-ups.

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[7] The SLIMS package is not connected to the Shipyards' Banyan-Vines LAN.

Apart from these start-up problems, the LAB-SAM version of SLIMS was inadequate for the shipyards' because of the problems discussed in the following subsections.

Performance. The HP-1000 hardware and operating systems could not keep up with the demands of serving as an instrument interface, networking traffic, and running the more rigorous CHEM-LMS software.

Procedural. The ELAC wants to include the actual text of the analysis procedures as part of the SLIMS display, with boxes, "pick-lists," radio buttons, and so forth added to the text where appropriate for data entry by the operator. This type of text display was not possible with the LAB-SAM package. Moreover, the LAB-SAM software package couples the procedures for processing the samples with the data structures used to store the results.

Hierarchical Data Structure. The hierarchical data structure used by LAM-SAM (where all information about a sample was stored under its Sample-ID) created several problems. Most notably, it made it impossible to use different procedures to analyze for different compounds within the same sample. What was needed was a "flat" hierarchical data structure such that different procedures can provide different pieces of data for a sample within the integrity constraints established by the RDBMS.

Data Independence. The organization, format, and sometimes the actual values of data are inextricably linked with the actual application in LAB-SAM. Consequently, changing the format of a data field requires changing the applications too.

Proprietary. LAB-SAM is a proprietary application. Other applications cannot "talk" to the LAB-SAM software, nor can NAVSEA 07Q (LABS) purchase third-party applications such a report writer, forms packages, and so forth to interact directly with the SLIMS data files.

These limitations of the original SLIMS design convinced the SLIMS staff that they needed to redesign the system. In particular, they wanted to move away from proprietary hardware and software systems towards open systems standards such as GOSIP[8] and POSIX[9]. They chose to develop the next generation of SLIMS on a HP-9000 computer platform running the UNIX operating system and to use Hewlett-Packard's® CHEM-LMS software package as a client application to the commercial RDBMS Oracle as a database server. The HP-1000 computers will be retained to serve as an interface to the analytical instruments and to run the LAB-SAM software. Retaining LAB-SAM is necessary because it has no data export capability. The data stored in the current SLIMS can only be accessed from LAB-SAM.

Because the current HP-1000/LAB-SAM combination is straining under its workload, and because the SLIMS staff knew there would be a long development time to field the target version, they

[8] GOSIP (Government Open Systems Interconnect Profile): The OSI Reference Model of network architecture and a suite of protocols (seven-layer protocol stack) to implement it were developed by ISO in 1978 as a framework for international standards in heterogeneous computer network architecture.

[9] POSIX (Portable Operating System Interface): A set of IEEE standards (IEEE 1003.1—1003.4) designed to provide application portability.

elected to use an interim configuration. Like the target configuration, the interim system uses a HP 9000 minicomputer running UNIX. However, the LIMS software package on the interim configuration is another Hewlett Packard product, LAB/UX. LAB/UX is essentially LAB-SAM for UNIX. This will allow the SLIMS staff to upgrade to the next generation of SLIMS while continuing to support operational users and without losing the effort and design that went into the original design. The NNSY and PNSY chemistry laboratories are using the LAB/UX version of SLIMS; PHNSY and PSNSY are being brought online.

Apart from hardware and software issue, some problems encountered using SLIMS arose from management issues. SLIMS standards were developed collectively by the SLIMS managers at all the shipyards. The implementation of these standards was a local decision. The extent and success to which they were implemented depended largely on the time, abilities, and motivation of the local SLIMS managers. Some laboratories preferred to use a locally developed procedure and wrote their own SLIMS procedure to process the data. The automated procedures used by each shipyard's SLIMS are therefore different, and this presents configuration management problems for the SLIMS staff in NAVSEA 07Q.

Recommendations

SLIMS. SLIMS is a significant potential source of measurement data for the integration of the shipyard's environmental programs. SLIMS (see section 10) produces a digital record of the measurement values for the samples processed by the shipyards' chemistry laboratories. It also tracks some of the supporting data and metadata (e.g., sample identifiers, measurement QA/QC values, etc.).

SLIMS is currently being upgraded (see above). The CHEM-LMS version of SLIMS will use the Oracle® RDBMS as a back-end data manager. This configuration is based partially on the decision of the SLIMS project to follow an open standards architecture with this next generation of SLIMS. It also allows the shipyards to interconnect their databases on the HP-9000s using Oracle's® SQL*Net package over the TCP/IP network backbone[10]. This would enable applications other than SLIMS to retrieve data from the SLIMS database using SQL*Net. Thus, SLIMS could be the repository for measurement data derived from analytical chemistry and supporting measurements; other databases could be repositories for field measurements, project data, and so forth. Therefore, it is important that development of any environmental database for the shipyards is closely coordinated with the development of SLIMS.

Environmental Database. The long-term objective should be to organize the shipyards' environmental measurement data into an integrated database managed by a commercial RDBMS. Each shipyard should maintain a local database containing its data and these databases should be interconnected through a common RDBMS (i.e., a distributed architecture). The appropriate RDBMS and its configuration cannot be recommended until the users' requirements have been defined during the first three phases of the current study. The general user requirements that will be investigated include the following:

1. A logical view of the data (the data model);
2. The size and volatility of the database;
3. End-use applications (statistical, graphical, etc.);

[10] SLIMS does not use the shipyard's Banyan-Vines LAN, but uses standard Internet TCP/IP protocols.

4. Security considerations (access control);
5. The distribution of the users and the data.

HARDWARE, SOFTWARE, AND COMMUNICATIONS SUPPORT

Background

While using an RDBMS to manage environmental data has many advantages in its own right, the primary objective of the database is to provide users with access to the data. Users must have the hardware, software, communications, and training to access the database. These topics are discussed in the following subsections.

Database Server. The topic of distributed versus centralized database architectures is discussed in Date (1995). A database can be local, running on a user's desktop computer (i.e., workstation), or on a remote computer that is accessible from the user's workstation through a network. Whether local or remote, the following discussion assumes that there is only one database per Environmental Division, more than one person uses the Division's database, and users access the database from their desktop workstation. These assumptions do not preclude the database from being hosted on a desktop workstation that also functions as a database server to other workstations on the network. It also does not preclude the database being hosted on a computer that is not physically in the division, or even at the shipyard.

Workstations. A desktop workstation is a computer that is small enough to fit on a user's desk, but powerful enough to perform most office functions. Typical office functions at the Environmental Divisions that fall in this category would include the following:

1. Database access;
2. Data analysis (statistical, graphical);
3. Data presentation (viewgraphs, reports);
4. Report preparation (DMRs);
5. General correspondence (word processing);
6. Electronic mail;
7. Contract management;
8. Internet access.

In most business environments, a desktop workstation is either an Intel-based personal computer (PC) running Microsoft Windows or an Apple Macintosh. The hardware and software requirements for a PC-based workstation to support the Environmental Divisions' requirements[11] are discussed below. Note that database access is only one of many potential applications for desktop workstations in the Environmental Division. Apart from the purchase of the RDBMS software, most of the requirements for a workstation to support environmental data management in the divisions are the same as the requirements for general computing in a modern office.

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[11] While both PCs and Macintosh are suitable candidates for the Environmental Divisions' applications, none of the divisions are presently using Macintosh computers.

Communications. A workstation can perform the functions outlined above in "standalone" mode, that is, without being connected to any other computers. For various technical and procedural reasons, applications such as the environmental database and electronic mail will probably be hosted on a remote (at least to the end-user) computer. The user's workstation therefore must be connected to a communications network that links his desktop workstation (the "client") with remote computers (the "servers") that provide these services.

Based on their geographic extent, communication networks are of two basic types. Local area networks (LANs) are usually limited to a building or a campus (e.g., a shipyard or naval station), but may extend to several tens of miles in any direction. The Banyan-Vines LAN at most of the shipyards falls into this category. Usually, the people connected to a LAN share some common attribute; they work in the same building or work for the same organization. Computers are added to the LAN by installing a network card in an open slot in the computer's motherboard, assigning a unique LAN address to the card, and connecting the card to the network through a cable (e.g., coaxial, fiber-optic, infrared). Small software applications called "drivers" serve as an interface between the computer's operating system and the network.

Some computers on the LAN function as servers to other computers, providing services such as extra disk space, shared software applications, and administrative services. Servers run some form of network operating system that enables them to provide their services to other computers on the LAN. Other specialty computers on the network may serve as bridges between different parts of the LAN, route packets of information to different parts of the LAN, or serve as a "gateway" between different LANs.

The second type of network, a wide area network (WAN), may have a similar configuration to a LAN but cover larger area; it may be worldwide. The different "nodes" on a WAN may be connected through leased telephone circuits ("long lines") or satellite circuits. Again, the users of a WAN usually work for the same company or subscribe to the same online services.

An "internetwork" is a network of networks. The networks can be LANs or WANs that communicate with one another through a gateway that translates whatever protocol they are using into the protocol used on the internetwork. The most widely known internetwork is the Internet. The Internet uses the TCP/IP protocol.

Training. While workstation environments are becoming increasingly more "user-friendly," it is unreasonable to expect those division personnel to learn how to use these tools effectively on their own. The division staff will need to be trained to use the basic workstation tools and the specific environmental information management applications.

Current Status

The environmental staffs at the shipyards currently have limited access to computer and communications technology. Sometimes this is because of a lack of suitable hardware and software. Elsewhere, the hardware and software are not used because the staff lacks the training to effectively use the hardware and software or relevant data is not in digital form.

Table 10 summarizes the current workstation hardware and software used at the five shipyards. Most shipyards are standardizing on Microsoft Office® as their office software suite. Microsoft Office® includes a word processor (Word for Windows®), spreadsheet (Excel®), graphics program (PowerPoint®), and e-mail (Microsoft Mail®). Microsoft Office® (Professional) provides the (Access®) database capability. Since Microsoft Office® only operates under Microsoft Windows®

(including Windows for Workgroups®), this trend would also imply movement towards adopting Microsoft Windows® as the operating system standard for workstations at the shipyard.

All U.S. Navy shipyards have a Banyan-Vines LAN and most buildings at the shipyards are wired for LAN access. The LAN servers use the Vines operating system and the network supports the Vines/IP protocol. The LANs at the five shipyards are interconnected into a WAN. At any shipyard, users with proper access can access computers anywhere on the WAN.

The WAN also supports outgoing access to the Internet, including Internet e-mail, login to remote sites (i.e., Telnet), file transfers (i.e., FTP), and limited use of WWW, Gopher, and other Internet exploration tools. Each shipyard also has one or more host computers that are not connected to the Banyan-Vines WAN, but are connected to the Internet (table 11).

Table 10. Workstation hardware, software, and communications at the shipyards.

Shipyard	Workstation	Software	LAN-Connected
Long Beach	386- and 486-based	DOS; WordPerfect, Excel, FoxPro	No (7/94)
Portsmouth	286-, 386- and 486-based (Chem Lab)	Windows; Microsoft Office	Yes
Norfolk	386- and 486-based	Windows; Microsoft Office, Super-Cal	Some[12]
Puget Sound	386- and 486-based	Windows; Microsoft Office	Yes
Pearl Harbor	286-, 386- and 486-based. (Chem Lab)	Windows; Word-Perfect, Excel, Lotus 123, Microsoft Office	Yes

[12] There is some resistance to connecting to the LAN because NAVSEA has a general policy that a workstation cannot be connected to the LAN and have a modem too. Some users think it is more valuable to have a modem and be able to communicate with the external computer services than to be connected to the LAN.

Table 11. Internet hosts at the shipyards.

Shipyard	Host Name (.navy.mil)	IP Address	Updated	Technical Point of Contact
Long Beach	lbnsy-gw	150.111.0.0	12/21/93	Dennis Crawford, crawford@dns1. lbnsy.navy.mil
Portsmouth	ports	146.68.170.2	10/12/92	Thomas Dunn, tom@poe.ports. navy.mil
Norfolk	nor-navshpyd	157.141.0.0	6/13/94	Robert Asheim, [none]
Puget Sound	puget-poe-gw	192.42.41.1	11/11/93	Cunningham, Eugene E. gene@dns1.psns.na vy.mil
Pearl Harbor	Net-phnsy-poe-gw	192.58.181.0	3/3/91	Mr. Val Rowe. val=rowe%synocc %phnsy@nsoo.phn sy.navy.mil

Recommendations

The specific workstation that division personnel will require depends upon the applications they will use. Because these applications will not be defined until Phase III of the current study, the hardware and software recommendations will not be made until Phase IV. However, based on the microcomputer marketplace and the general requirements of the Environmental Divisions, the following are the ***minimum*** configurations that should be considered for all ***new*** workstation purchases:

1. Hardware

    Pentium 100-MHz processor

    230-W Power Supply

    16-M 70-ns 72-pin SIMM RAM

    1-G Hard drive

    1.44-M 3.25-inch floppy drive

64-bit video card (2M RAM)

1280 x 1024 SVGA Monitor

16-bit SCSI-2 sound card

Speakers

Quad-speed CD-ROM drive

16-bit Ethernet card

2. Software

Windows95®

Microsoft Office for Windows95®

Microsoft Access[13] for Windows95

World Wide Web browser (e.g., Netscape for Windows®)

Internet-compliant e-mail program

3. Communications

Banyan-Vines connectivity

Full Internet connectivity

4. Training

Windows for Workgroups®

Microsoft Office®

World Wide Web browser

E-mail program (if not included in MS Office®)

Environmental data management application

SUMMARY OF RECOMMENDATIONS

- Each shipyard should collect all of its existing environmental documents into a central library and develop a computerized catalog of its holdings.
- Environmental source documents delivered in digital form should be copied to new read-only magnetic media (e.g., diskettes) and stored in a managed area.

[13] Microsoft Office Professional® for Windows 95® includes Access®.

- Contractors who conducted environmental studies for the shipyards in the past 5 years should be contacted to find out if the data and/or reports from those studies are still available in digital form; where available and cost-effective, these digital sources should be incorporated into the shipyards' holdings.
- NRaD will develop an environmental data reporting specification for the shipyards during Phase II of this project. The shipyards should incorporate this specification into their in-house and contractual procedures to ensure primary measurement data are reported in a fully documented digital form.
- NRaD will also be developing an environmental data model during Phase II of this project. this data model will be a reflection of the types and uses of environmental data for the shipyards; it will also be the progenitor of the data reporting specification, the database definition, and the data management plan that follow. It is important, therefore, that the NRaD staff has ready access to shipyard personnel who collect, manage, and use environmental data.
- The Environmental Division staffs must have suitable workstations and network connections to take advantage of an online environmental data system. They must also receive training for these tools and be encouraged to use them as part of their normal office routine.

10. ENVIRONMENTAL LABORATORIES

INTRODUCTION

Environmental testing is the process of measuring the constituents of the natural environment or of materials before they are released into the natural environment. Sample (1994) recently completed an in-depth analysis of the U.S. Navy's environmental testing program, including the cost of those programs to the shipyards. Her report includes a detailed breakdown of testing costs for compliance versus restoration programs by States, and for government versus contract laboratories.

This chapter focuses on the capabilities that the shipyard laboratories will need to support an integrated environmental compliance program[14]. Specifically, the following sections discuss the laboratories' requisite:

- Analytical capabilities
- Quality control/certification
- Automated record keeping

ANALYTICAL CAPABILITIES

Background

Each of the five shipyards included in this study has an in-house chemistry laboratory that analyzes, among other materials, environmental samples for compliance with regulatory standards or the restoration of contaminated sites. These laboratories are equipped and staffed to measure various chemicals in the shipyard environments. Because U.S. Navy shipyards are located in estuarine environments, and because most of their environmental testing requirements derive from the CWA or RCRA, the analyses done by these laboratories are primarily on water samples rather than other media (e.g., sediments, air). None of the shipyard chemistry laboratories is currently doing biological analyses (e.g., bioassays), although some may in the future.

Note that environmental testing in support of installation restoration (including CLEAN) makes up fully two-thirds of the U.S. Navy's environmental testing costs (Sample, 1994). However, nearly all IR testing is done by contractors hired to conduct the installation restoration. Moreover, NAVFAC administers most IR programs and, thus, these programs do not appear on the shipyards' testing ledger.

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[14] The laboratories' other testing activities, including metallurgical, nuclear, and non-environmental chemistry are not discussed in this report.

As noted above, most of the environmental testing currently done by the shipyards is to ensure compliance with CWA and RCRA regulations. These requirements include testing of the following:

- Point-source discharges
  - NPDES
  - Stormwater
- Discharges to POTWs
- Hazardous wastes
  - Sewage sludge
  - Waste oil

Environmental testing may also include measurements made in the field. These might include the use of *in situ* instruments such as current meters or rain gauges, measurements made with portable instruments such as Conductivity, Temperature, Depth (CTD) meters or Secchi disks, or direct observations such as counting the number fish in a visual transect. Shipyard personnel make some field measurements, such as pH determinations on wastewater samples. More often, samples of water, sediment, or tissue are collected in the field and returned to the laboratory for analysis.

The Environmental Laboratory Advisory Council (ELAC), sponsored by CNO-N45 and chaired by Maude Bullock, is spearheading initiatives to improve the capabilities and quality of the U.S. Navy's environmental testing facilities, in-house and through contract laboratories. These initiatives are attempting to broaden the range of analytes tested and increase the sensitivity of those measurements. The following discussions present the same issues from the perspective of measuring risk-based ecological effects.

Current Status

Organization. The chemistry laboratories at the five shipyards are organized into the following operational units:

LBNSY

- Production
- Environmental
- IWTP

PNSY

- Nuclear Water Chemistry
- Analytical Chemistry

NNSY

- Environmental
- Nuclear

Analytical

IWTP

PSNSY

Environmental

Analytical

Nuclear

Metallurgical

PHNSY

Environmental and Analytical

Paints and Coatings

Petroleum

Metallurgy

Most shipyards have a separate laboratory associated with their IWTP. The IWTP laboratories were set up to rapidly analyze industrial process water (including bilge water) before discharging it into the POTW. The tests done by the IWTP laboratories generally require less precise analyses than those performed by the chemistry laboratories.

Instrumentation. Table 12 summarizes the analytical instruments that are used at the five shipyard chemistry laboratories. Note that these instruments can measure environmental samples at the level of analytical precision outlined in table 13.

Sample Collection. The shipyard chemistry laboratories generally do not collect the samples they analyze. The samples are brought to them for analysis of a prescribed list of contaminants. The laboratory reports the results back to the activity. Together with these analyses, the laboratories must also keep track of sample information (e.g., sample number, owner, processing date, and so forth) and laboratory QA/QC results (e.g., batch number, measurement values for blanks, standard reference materials, and so forth). At some shipyards (e.g., PNSY), all environmental samples are processed through the chemistry laboratory, including those analyzed externally by a contractor. This is, however, the exception, and at LBNSY and PSNSY, the Environmental Division and Public Works may contract directly without outside laboratories and not involve the chemistry laboratory at all.

Staffing and Workload. The staffing devoted to environmental testing at the shipyard chemistry laboratories (not including the IWTP laboratory staffs) varies from none at PNSY to 35 staff members at PSNSY. In general, most of the laboratories report that they could process a higher percentage of the shipyard's environmental samples if they could staff more billets that are full-time for laboratory technicians.

Table 12. Analytical instrumentation and analyses at the shipyard chemistry laboratories.

Instrument/ Analysis	Shipyard				
	LBNSY	PNSY	NNSY	PSNSY	PHNSY
AA/GF		1	1	1	1
GC/MS	1		1	4	1
GC		3	3	7	2
ICP	1	1	1	1	1
ICP/MS	1	1	1	1	
Nutrient Analyzer					1
SLIMS	1	1	1	1	1
TCLP		1		1	1
TOC		1			1
Infrared Analyzer		1			1
Wet Chemistry	1	1			
TOTAL	5	11	8	16	10

Table 13. Chemical analytes, sample matrices, target detection limits, and achieved detection limits obtained by the analytical laboratories participating in the Estuarine Study (modified from Munns et al., 1994)

A. Organic compounds (dry weight for sediment and biota).

Analyte	Sample Matrix	TARGET MDL	ACHIEVED Lab-[1]	Lab-2[2]	Lab-3[2]
Volatile Organic Compounds	**seep water**	**0.1 ug/L**	**0.3 - 0.4 ug/L**		

vinyl chloride	trans-1,3-dichloropropene
1,1-dichloroethene	tetrachloroethene
methylene chloride	chlorobenzene
trans-1,2-dichloroethene	bromoform
chloroform	1,1,2,2-tetrachloroethane
1,1,1-trichloroethane	1,3-dichlorobenzene
carbon tetrachloride	methyl-t-butyl ether
1,2-dichloroethane	benzene
trichloroethene	toluene
1,2-dichloropropane	ethylbenzene
bromodichloromethane	m,p-xylene
2-chloroethylvinyl ether	o-xylene
cis-1,3-dichloropropene	1,2-dichlorobenzene

Analyte	Sample Matrix	TARGET MDL	ACHIEVED Lab-[1]	Lab-2[2]	Lab-3[2]
Polycyclic Aromatic	**seep water**	**1-5 ug/L**	**1- 4 ug/L**	**0.05 ug/L**	
Hydrocarbons	**sediment**	**1-5 ng/g**	**3-21 ng/g**	**20.0 ng/g**	
	biota	**10-20 ng/g**	**3-25 ng/g**	**5.0 ng/g**	**4.6-12.4 ng/g**

anthracene (ANTH)	phenanthrene (PHEN)
benz(a)anthracene (BAA)	C_1 alkyl phenanthrenes + anthracenes (C1)
benzo(a)pyrene (BAP)	C_2 alkyl phenanthrenes + anthracenes (C2)
benzo(e)pyrene (BEP)	C_3 alkyl phenanthrenes + anthracenes (C3)
chrysene (CHRYSENE)	C_4 alkyl phenanthrenes + anthracenes (C4)
dibenz(a,h)anthracene (DIBAHA)	pyrene (PYRENE)
fluoranthene (FLUORAN)	benzo(g,h,i)perylene (BGHIPER)
fluorene (FLUORENE)	indeno(1,2,3-cd)pyrene (INDEN123)

A. **Organic compounds** (dry weight for sediment and biota).

Analyte	Sample Matrix	TARGET MDL	Lab-[1]	ACHIEVED Lab-2[2]	Lab-3[2]
perylene (PERYLENE)	sum of benzofluoranthenes (SUMBENZ)				
sumPAH = sum of the 18 measured PAH compounds					
Chlorinated Pesticides	**seep water**	**0.6 ug/L**	**0.6-0.9 ng/L**	**0.05 ug/L**	
	sediment	**0.6 ng/g**	**0.1-0.6 ng/g**	**0.60 ng/g**	
	biota	**0.6 ng/g**	**0.1-2.4 ng/g**	**0.60 ng/g**	**0.1-0.6 ng/g**
aldrin (ALDRIN)	alpha-chlordane (ACHLOR)				
trans-nonachlor (TNONACHL)	Heptachlor (HEPCHLOR)				
Hepachlor epoxide (HEPEPX)	hexachlorobenzene (HCB)				
Lindane gamma-BHC (LINDANE)	Mirex (MIREX)				
o,p'-DDD (DDDOP)	p,p'-DDD (DDDPP)				
o,p'-DDE (DDEOP)	p,p'-DDE (DDEPP)				
o,p'-DDT (DDTOP)	p,p'-DDT (DDTPP)				
tDDT = sum of DDT and metabolites DDE and DDD					
tCdane = sum of chlordane mixtures ACHLOR, TNONACHL, HEPCHLOR and HEPEPX					
Polychlorinated Biphenyl	**seep water**	**1 ug/L**	**0.5-0.6 ug/L**	**0.05 ug/L**	
Congeners [Congener number	**sediment**	**0.5 ng/g**	**0.1-1.9 ng/g**	**0.50 ng/g**	
and position of chlorines]	**biota**	**0.5 ng/g**	**0.2-0.6 ng/g**	**0.50 ng/g**	**0.06-0.2 ng/g**
8 [2,4'] (PCB8)	18 [2,2',5] (PCB18)				
28 [2,4,4'] (PCB28)	52 [2,2',5,5'] (PCB52)				
44 [2,2',3,5'] (PCB44)	66 [2,3',4,4'] (PCB66)				
101 [2,2',4,5,5'] (PCB101)	118 [2,3',4,4',5] (PCB118)				
153 [2,2',4,4',5,5'] (PCB153)	105 [2,3,3',4,4'] (PCB105)				
138 [2,2',4,4',5,5'] (PCB138)	187 [2,2',3,4',5,5',6] (PCB187)				
128 [2,2',3,3',4,4'] (PCB128)	180 [2,2',3,4,4',5,5'] (PCB180)				
170 [2,2',3,3',4,4',5] (PCB170)	195 [2,2',3,3',4,4',5,6] (PCB195)				
206 [2,2',3,3',4,4',5,5',6] (PCB206)	209 [2,2',3,3',4,4',5,5',6,6'] (PCB209)				
SUMPCB = sum of 18 PCB congeners measured					
tPCB (sediment) = 2.01 * SUMPCB - 1.55					

tPCB (tissue) = 1.95 * SUMPCB + 2.1

B. Inorganic elements (Dry Weight for Biota and Sediment).

Analyte	Sample Matrix	TARGET MDL	Units	ACHIEVED Lab-[1]	Lab-2[2]	Lab-3[2]	Lab-4[2]
Aluminum (Al)	water	75.0	ug/L	84.0	100.0	40.0	
Aluminum	sediment	NS	ug/g	10.7	19800.0	4563.0	
Aluminum	biota	NS	ug/g	8.17	34.0	4.0	
Arsenic (As)	water	3.0	ug/L	15.0	0.5	0.86	
Arsenic	sediment	1.1	ug/g	0.52	2.5		
Arsenic	biota	4.3	ug/g	3.2	1.2	0.29	
Cadmium (Cd)	water	0.2	ug/L	4.0	0.2	5.0	0.011
Cadmium	sediment	0.35	ug/g	0.13	0.1	5.0	
Cadmium	biota	0.055	ug/g	0.05	0.44	0.03	
Chromium (Cr)	water	3.0	ug/L	15.0	1.0	0.04	
Chromium	sediment	3.16	ug/g	1.65	33.0	10.0	
Chromium	biota	0.28	ug/g	1.85	0.4	0.04	
Copper (Cu)	water	0.7	ug/L	300.0	0.2	15.0	0.057
Copper	sediment	1.25	ug/g	4.55	5.5	2.0	
Copper	biota	5.0	ug/g	2.01	2.7	0.3	
Iron (Fe)	water	20.0	ug/L	90.0	20.0	60.0	
Iron	sediment	NS	ug/g	7.6	2600.0	2514.0	
Iron	biota	NS	ug/g	6.6	26.0	10.0	
Lead (Pb)	water	3.0	ug/L	1.5	0.2	0.3	0.033
Lead	sediment	1.2	ug/g	0.81	6.2	0.6	2.4
Lead	biota	0.6	ug/g	0.13	0.09	0.03	
Manganese (Mn)	water	0.5	ug/L	15.0	0.5	8.0	
Manganese	sediment	NS	ug/g	0.97	50.0	19.0	
Manganese	biota	NS	ug/g	0.60	1.8	0.1	
Mercury (Hg)	water	5.0	ug/L	0.6	0.001		
Mercury	sediment	0.007	ug/g	0.448	0.01		
Mercury	biota	0.036	ug/g	0.079	0.006		
Nickel (Ni)	water	3.0	ug/L	30.0	0.2	0.1	0.072
Nickel	sediment	1.5	ug/g	2.76	7.5	5.0	
Nickel	biota	0.73	ug/g	3.45	0.54	0.1	
Silver (Ag)	water	3.0	ug/L	15.0	0.01	5.0	
Silver	sediment	0.04	ug/g	0.15	0.04		
Silver	biota	0.037	ug/g	0.091	0.30	0.07	

Tin (Sn)	water	3.0	ug/L		0.05		
Tin	sediment	1.75	ug/g	0.81	0.5		

B. Inorganic elements (Dry Weight for Biota and Sediment).

Analyte	Sample Matrix	TARGET MDL	Units	Lab-[1]	ACHIEVED Lab-2[2]	Lab-3[2]	Lab-4[2]
Zinc (Zn)	water	0.5	ug/L	1500.0	1.0	9.0	
Zinc	sediment	2.15	ug/g	1.1	7.8	2.0	
Zinc	biota	11.65	ug/g	11.3	27.0	5.0	

C. Organometalic Compounds. (Dry Weight for Biota and Sediment).

Analyte	Sample Matrix	TAR.GET MDL	Units	ACHI.EVED Lab-5[1]	ACHI.EVED Lab-2[2]
Butyltins					
monobutyltin (MBT)	sediment	2.0	ug/g	2.0	
	biota	2.0	ug/g	2.0	
dibutyltin (DBT)	sediment	2.0	ug/g	2.0	
	biota	2.0	ug/g	2.0	
tributyltin (TBT)	sediment	2.0	ug/g	2.0	
	biota	2.0	ug/g	2.0	
TOTIN = sum of TBT, DBT, and MBT					
Methyl-Mercury (meHg)	biota	NS	ng/g		0.02

1. Phase I of estuarine study
2. Phase II of estuarine study
NS = Not specified

Recommendations

The shipyards' environmental testing is, for the most part, organized around programs that derive from existing regulations, including NPDES, RCRA, and so forth. To move away from programmatic compliance towards an integrated approach based on risk assessment of ecological effects, the shipyards' analytical capabilities should include the following:

- Analysis of sediment and biological tissues, as well as water samples
- Analysis of dissolved, particulate, and total fractions of target compounds
- Detection limits in the low part-per-billion (i.e., *ng/g*) concentration range for all media, including seawater.
- Reliable recovery rates for all sampled media
- Bioassay and biomarker studies
- More reliable field sampling methods and sample processing

Analytical Chemistry. Table 13 summarizes the target detection limits established by the PNSY ecological risk assessment project (Munns et al., 1994). These targets were established for the listed organic and inorganic compounds in (seep) water, sediment, and tissue samples. The actual detection limits achieved by the laboratories that processed the PNSY samples are also reported. The target and actual values are presented here as representative of the limits the shipyard laboratories should be striving to attain in support of risk-based assessments. The detection limits of each shipyard depend upon the regulatory requirements under which they operate and the time, cost, and other resources that they commit to achieving these goals.

Biological/Ecological Effects. The shipyards' environmental testing mostly involves measures of the chemical constituents in effluents and solid waste (table 2). However, the shipyards are conducting some biological testing, particularly bioassays (table 3). Ecological risk assessments will require even more biological testing, including measures that are more directly related to biological and ecological interactions. Besides the EPA-approved bioassays, these additional tests might include molecular biomarkers, biochemical testing, and measures of community structure and function.

Until recently, the shipyard's biological testing was all done under contract. Two shipyards (PSNSY and NNSY) are presently testing the Qwiklite bioluminescence bioassay developed at NRaD (Lapota et al., 1994). Qwiklite provides more rapid screening for possible biological effects of marine pollutants. These shipyards are evaluating Qwiklite for discharge monitoring under NPDES and for monitoring the toxicity of the waste stream from their IWTP facilities[15]. The Qwiklite method is currently under evaluation by the ASTM as a standard marine bioassay.

Other biochemical tests suitable for the marine environment are under development at NRaD and elsewhere. These include the "Comet" DNA strand break assay (Shugart et al., 1992), enzyme assays, particularly those employing the enzyme cytochrome p450, and various other biomarkers (Hugget et al., 1992). Note, however, that these tests are in the research and development phase. Even those that are furthest along in this process probably will not be available for routine use for 2 to 3 years.

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[15] Personal communication with Dave Lapota.

The suitability and applicability of these tests will depend upon several factors. First, the tests must be accepted by the regulators instead of conventional biological tests. Second, the tests must be shown to be biologically or ecologically significant; that is, the assay predicts an actual and relevant change in the natural environment. Third, the regulatory agencies must accept risk-based assessment, including biological and ecological assay criteria as an alternative to the current measures of pollutant concentration.

The operational cost of doing biological testing at the shipyard laboratories must also be considered. The minnow, mysid shrimp, and sea urchin assays currently approved by EPA require a substantial capital investment in facilities to rear and/or maintain these organisms for testing. Since bioassays are only done twice a year at the shipyard, the expenditures to add these types of bioassays to the repertoire of the shipyard laboratories is prohibitive. Perhaps if the U.S. Navy consolidates its environmental testing laboratories into regional centers (see below), the volume of bioassay testing might be enough to justify the setup and training costs. Otherwise, it would be more cost-effective to contract out these tests to commercial laboratories that do have enough volume to justify the operational costs.

These same arguments might apply when the new biological tests under development become commercially available. Moreover, because these tests are new, it will be more difficult to find qualified technicians to perform them. Again, instituting regional U.S. Navy environmental laboratories with enough volume may improve this situation.

Measurement Accuracy/Precision. Understanding the ecological effects of shipyard activities will require more sensitive measurements of physical and chemical parameters, and more careful procedures to ensure the measurements reflect actual environmental conditions. These changes may require the laboratories to:

- Implement clean or ultra-clean laboratory techniques to measure trace-levels of materials where necessary;
- Measure different fractions of environmental contaminants (e.g., dissolved metals in sediment interstitial waters rather than total metals);
- Adopt more stringent procedures for preparing, collecting, processing, and handling samples in the field so that high-precision laboratory measurements are not compromised by mishandling of the samples in the field;
- Make ancillary measurements such as salinity, dissolved organic carbon, total suspended solids, grain size, and so forth to assist in the interpretation of other measurements.

Limits of Detection. Keith (1991) has discussed the issues underlying the question of when to report analytical results as "Not Detected" (ND). This issue spans the gap between analytical procedures and data reporting. The position of the American Chemical Society (ACS) is that measured values below the stated detection limits (e.g., MLD or LOQ.) should be reported as "ND." The ACS position assumes that reporting the measured value and a QA/QC "flag" to indicate the value is below the detection limit runs the risk that an uncertain number will become a certain one if the QA/QC qualification is left behind when the value is used by others. The opposite position, held by the American Society of Testing and Materials (ASTM), is that reporting analytical results as "ND" amounts to "censoring" the data. ASTM believes that important information about the variability of measurements at these low levels is lost when all such values are reduced to "ND."

While NRaD recognizes the validity of ACS's concerns, we believe those concerns are a data management issue, not an analytical one. From a data management standpoint, "ND" is a non-value. The characters "ND" cannot be recorded in a numeric data field. The same is true of recording the detection limit preceded by "<" to denote" less than." "ND" cannot be replaced by a blank field (no measurement was made) or by zero (no analyte was detected). Therefore, NRaD recommends that the shipyard chemistry laboratories report all measured values as recorded, along with the measured sample controls (e.g., field and laboratory blanks, standard reference materials, duplicate analyses, and so forth), analytical detection limits, and analytical methods used. This leaves the chemistry laboratories the responsibility of judging quality of the data, but not for interpreting the data they report. It gives end-users the responsibility of judging the appropriateness of measurements for a particular application. It also requires a data management system that can record and link measurements and controls to alert the users to the uncertainty of the numbers they are using.

Environmental Media. Aquatic environmental regulations are based on measures of water quality. Most compliance-based environmental testing is, therefore, limited to water samples. However, many of the most serious pollutants are rapidly adsorbed on particles in the water column and transferred to the sediments where they are concentrated by biotic and abiotic processes (Di Toro et al., 1991). The partitioning of these compounds among the various dissolved and particulate fractions also affects their bioavailability. In recognition of these processes, state and federal regulators are developing sediment quality criteria (USEPA, 1993b, 1994g). Environmental testing laboratories must therefore have the methods and instrumentation for both water- and sediment-based measurements.

Bioaccumulation and biomagnification are important in understanding the impact of pollutants on the environment. Measurement of these processes will require the environmental testing laboratories to measure contaminant concentrations in biological tissues. Salt is another confounding factor in making high-precision analytical measurements in seawater, particularly analyses of heavy metals.

Measurement Data. The objective of sharing measurements among different projects and applications (section 9) requires the environmental laboratories to report not only the original measurement values, but also the supporting and associated information. The analytical laboratories must record this information for each sample, store it in digital form, and make the data available to other users and applications outside the laboratory environment. Sharing data will further require the laboratory's information management system to be compatible with other environmental data management systems at the shipyard.

Capacity/Throughput. The analysis of trace contaminants in sediment and biological tissues will require more careful and, therefore, more time-consuming sample preparation and processing than are used by the chemistry laboratories today. The laboratories must balance the management of these requirements against those that require more rapid but less-precise tests. One problem the shipyard laboratories have encountered is the small number of samples they are processing. This drives up the unit cost of the samples. Commercial laboratories generally hold samples until they have enough to bring the per-sample cost down into a reasonable range. These laboratories charge more money—as much or more than the shipyard laboratories—if the customer needs samples sooner[16].

Sample (1994) has argued the U.S. Navy's in-house environmental testing facilities, perhaps organized into regional testing centers, can perform the requisite environmental analyses at a lower

[16] Personal communication with Ed Hartzog.

cost than commercial laboratories. Her report also recommends that these laboratories take on more of the U.S. Navy's IR testing, most of which is currently done by contractors. An integrated compliance program will require strictly comparable measurements, whatever the mix of in-house and contract testing. The requirements presented below for the shipyard chemistry laboratories therefore apply equally to commercial environmental testing laboratories.

QUALITY CONTROL AND CERTIFICATION

Background

"Quality control [QC] ... is an overall system of activities that controls the quality of a product or service so that it meets the needs of users" (Taylor, 1987); Quality Assurance (QA) "is the management system that ensures an effective QC system is in place and working as intended" (Keith, 1991). The QA/QC requirements of the user (shipyards) includes the following:

- Reliable and defensible environmental test results;
- Reduced costs by not overestimating contamination or making decisions based on inaccurate measurements;
- A better understanding of the shipyards' true impact on the environment;
- The credibility of the Navy environmental laboratories.

Quality control is a "cradle-to-grave" process. It begins before any samples are collected with the establishment of data quality objectives (DQOs), which define the degree of error or uncertainty that can be tolerated in the measurement data. It encompasses creating a Data Management Plan (DMP) for collecting, processing, analyzing, and reporting sample data that meet the DQOs. Finally, QC includes the definition and application of protocols, field and laboratory techniques, and reference materials (e.g., blanks, duplicates, and spikes) to control and document the quality of the measurements. Certification is the independent verification that a laboratory has, and is following, a QC plan that meets its DQOs.

The ELAC's initiatives include the establishment of QA/QC policies and procedures and the certification of these capabilities at the environmental testing laboratories used by the U.S. Navy. The present analysis will discuss only those additional aspects of shipyards' environmental laboratory QA/QC and certification programs that relate to the integrated compliance efforts.

Over the years, regulators have progressed from simply wanting to know the concentration of pollutants in the environment to requiring the testing laboratories to use standard methods of making these measurements. As those standard methods have continued to produce variable results, some regulators are now requiring laboratories to follow standard analytical QA/QC procedures and to report the results of blanks, reference materials, and so forth along with the environmental samples. To ensure these quality procedures are followed, regulatory agencies have also embarked on a program of laboratory certification.

Sample[17] has reviewed U.S. Navy initiatives to impro`ve environmental testing. These initiatives address the quality programs of both in-house and contract laboratory, including the following:

[17] Personal communication with Jacqueline Sample.

- Navy policy for quality laboratory testing;
- A regional network of environmental laboratories;
- Increased in-house expertise and cost-effective U.S. Navy laboratories;
- Environmental laboratory advisory council;
- Laboratory customer service group.
- Laboratory cost centers;
- U.S. Navy policy for quality laboratory testing;
- Consolidation of laboratory contracts;
- Contract improvement;
- Notification of important performance problems.

Current Status

QA/QC Plans. Most shipyard environmental laboratories either have or are in the process of preparing some form of an analytical quality control plan. In addition, some NPDES permits (e.g., LBNSY) include the requirement for a written QA plan. Included in these specifications are requirements for the frequency of QA samples (duplicates and spikes) and for participating in the discharge monitoring report QA performance study. Standard samples are sent to the participating laboratories during these performance studies to evaluate how well they recover the materials in the sample. As an example, the RI/FS sampling and analysis plan prepared for LBNSY under the CLEAN I contract (Southwestern Division, 1993a) has a very extensive Quality Assurance Project Plan (QAPP) section, including data management specifications.

These same NPDES permits also specify the types of records the permittees must keep to document their sampling and analysis efforts, and the period for which these records must be retained. Included in the list of reported parameters are the sampling date, time and place, the individuals who collected the sample or made the measurement, the methods used, and the results of the analyses.

Certification. Table 14 summarizes the source and level of certification at the shipyard chemistry laboratories as of March 1995.

Recommendations

The discussions that follow focus on the shipyards' laboratories; nonetheless, contract laboratories will continue to account for a significant fraction of the shipyards's environmental testing. This is particularly true for the IR testing done under contract by NAVFAC at the shipyard sites. Because these contract laboratories will represent a significant fraction of the total environmental measurement data generated from the shipyards, it is equally important that they follow the same or equivalent analytical, certification, and data reporting standards as the shipyard laboratories.

Under the umbrella of the general quality control program developed for the shipyards by NAVSEA, the shipyards should include a master Data Quality Objectives (DQO) and a Data Management Plan (section 9). These documents will set forth the general types of data to collect and the precision required for these data to quantify environmental status. The specific types and precision of analyses will vary between shipyards and among programs. Nonetheless, the general frame-

work will help to ensure closer coordination of data collection, data reporting, and data management. The USEPA has a series of documents to assist in the definition of quality requirements (i.e., the *EPA QA/R-xx* series) and guidance (i.e., the *EPA QA/G-xx* series).

All documents related to a laboratory's QA/QC program should be available in digital form, preferably in a standard word processing format such as ASCII, WordPerfect®, or Microsoft Word®. Ultimately, this information should be available through the same online interface as the measurement, supporting, and associated data. These documents might include the following:

- Data Quality Objectives;
- Laboratory Certification Report;
- Sampling methodology;
- Analytical methodology;
- Field notebooks;
- Laboratory notebooks.

Table 14. Shipyard chemistry laboratory accreditation (March 1995).

Shipyard	Certification	Analytes/Sampling
LBNSY	State (CA; May 1994)	Metals in drinking water, metals and chemicals in hazardous waste, and metals and chemicals in wastewater
NNSY	Environmental Protection Manual (Shipyard)	Sampling
	ISO/IEC Guide 25:1990	Laboratory QA/QC
	A2LA	All samples they collect
	NAVSEA	In progress
	State (VA)	Drinking water; in process
PNSY	NAVSEA	Metals, mechanical properties, and petroleum
	Environmental Protection Manual (PTSMHINST 5090.8)	Operating and management procedures for environmental sampling operations under Solid Waste, Hazardous Waste, Drinking Water, PCBs, Wastewater, and Underground Storage Tanks
PSNSY	A2LA	Metals, classical (wet) chemistry, purgeable organics, extractable organics, and PCBs for Non-potable Water samples; and metals, classical (wet) chemistry, purgeable organics, extractable organics, PCBs, and hazardous waste characteristics (ignitability and TCLP) for Solid/Hazardous Waste samples.
PHNSY	None	

All QA values (i.e., "associated data") should be stored with the measurement data and accessible through the same online interface. These QC values might include the following:

- Laboratory detection limits (e.g., MDL, LOQ). These values should be associated with the laboratory that made the measurements, the method and analyte to which they apply, the range of dates over which they apply, and the analytical results from which they were calculated (see below).
- Analytical results used to calculate detection limits; these values should be associated with the laboratory that made the measurements, the method used to make the measurements, the units in which the value is expressed, and all supporting information (e.g., name of analyst, date of analysis, materials used in analysis, and so forth).
- Analytical results from between-laboratory intercalibration studies.
- Per-batch analytical results for QC samples. QC samples are samples added to a batch of environmental samples to check the quality of the sampling, processing, and laboratory methods. QC samples may include (following the terminology of Keith, 1991):

  Environmental blanks

    Field blanks

    Trip blanks

    Matrix blanks

    Equipment blanks

    Material blanks

  Laboratory blanks

    Solvent blanks

    Reagent blanks

    Instrument blanks

  Duplicates

  Reference materials

    Certified reference materials

    Standard reference materials

    Local control materials

The values from the analysis of these QC samples should include the same supporting data as the measurement values for the environmental samples (e.g., parameter, property, method, and units).

All environmental testing laboratories used by the shipyards should be certified according to the guidelines NAVSEA 07Q is developing.

The shipyards should require their environmental testing laboratories to supply them with digital copies of the documentation for their QA/QC program. This would include the in-house chemistry laboratories, contract laboratories, and laboratories analyzing samples from the shipyards under the aegis of another agency (e.g., the IR samples collected by/for NAVFAC).

The shipyards should require their environmental testing laboratories to provide them with a digital copy of the measured values for all control sample analyses used in processing the shipyards' environmental samples. See section 9 for a discussion of the data reporting format for these values.

Whether the shipyards contract out their environmental testing to commercial laboratories or do the work in-house, special consideration must be given to collecting the samples in the field. High analytical precision in the laboratory will be negated by poor quality control for collecting and handling the samples in the field. Is it better to train laboratory personnel to collect samples for the Environmental Division, the IWTP facility, and other activities that are generating environmental samples? Is it better to train personnel from these activities to collect their own samples? Alternatively, is it better still to hire the contractor who analyzes the samples to also collect them? Whatever the decision, laboratory, activity, and contractor personnel should all be following the same set of procedures for processing samples in the field.

AUTOMATED RECORD KEEPING

Background

The following four factors underlie the requirement to increase automated record keeping in the shipyards' chemistry laboratories.

Staffing. Most directors of the chemistry laboratories visited during this study report their laboratories are understaffed. Even if the U.S. Navy's environmental testing laboratories are reorganized into "core" or "regional" centers (Sample, 1994), staffing these facilities with qualified technical personnel will continue to be a problem. If routine tasks can be accomplished through automation, the staff can devote more time to performing analyses.

Cost. In this period of DoD "downsizing," reducing or holding the line on costs is an important consideration. Cost enters the automation equation in several ways. By allowing the existing laboratory staff to process samples more efficiently, automation should hold down personnel costs. As a source of reliable, fully documented measurements for use and reuse by other projects, automation will help to amortize the cost of those measurements (section 9). As the requirements for more extensive record keeping grow, automation can reduce the space and personnel required to maintain these records. In other words, automation can bring down the cost per unit of useable data.

Digital Data. The requirement to provide a long-term record of fully documented measurements will continue to increase. These records will be required to provide the requisite spatial and temporal perspectives on environmental processes. They will also be needed to meet the legal and other requirements to substantiate measurement results. Collecting this information in digital form will greatly simplify meeting these requirements.

Scheduling. The number of samples to be processed and the complexity of the analyses to which these samples will be subjected will increase the laboratories' workload. Compounding this increase will be the need to balance the urgency of some samples against the time and expense of reconfiguring and re-calibrating instruments between analyses. Automation can greatly assist in scheduling samples to maximize throughput. Automation can also improve scheduling issues (and operational

costs) by detecting in near-real-time batches that exceed QA/QC specifications. These batches can then be rescheduled while the instruments are still appropriately configured.

The SLIMS package under development by NAVSEA 07Q provides many of the automation requirements outlined above (Sample, 1992, 1994). It can track samples, schedule tests, interface to analytical instruments, record quality control parameters, and generate data reports. The next generation of SLIMS, which is currently under configuration, will use a UNIX-based computer connected to the shipyards' LAN. It will also use open-system standards commercial software products including the Oracle® RDBMS as its data manager[18].

Current Status

SLIMS was originally fielded at PSNSY in 1988. Since then, SLIMS has been adopted by the remaining four shipyards. In that period SLIMS has saved the U.S. Navy an estimated $15M compared to performing the same functions manually[18]. SLIMS has, nonetheless, started to show its age, and NAVSEA 07Q (LABS) is replacing it with a more modern system. Section 9 discusses the specific hardware and software changes. The following paragraphs discuss the effect of the current SLIMS design on record keeping in the laboratories.

The current version of SLIMS uses Hewlett-Packard's LAB-SAM® software package. LAB-SAM® is a procedure-based program; the processing of information precedes from beginning to end in a stepwise, sequential fashion. Unlike a database system where the operator could access data records directly, data manipulation with LAB-SAM® requires the operator to follow the sequential procedures written for a particular analysis. The procedure and the organization of the data records generated by the procedure begin with the assignment of a Sample-ID.

The process begins when the user brings samples to the laboratory with an accompanying chain-of-custody form (LABSTD 3800B). Who collected the samples, when, where, and why (e.g., NPDES, IWTP) the samples were collected are recorded on the form. The laboratory technician assigns a Sample-ID and records the value on the chain-of-custody form and in SLIMS. The technician enters information from the form into SLIMS, including what analyses are to be performed and the date when the results are due. If the requested analyses are routine, the technician invokes a stored SLIMS procedure (i.e., a predefined set of program instructions) that automatically enters the routine information into the SLIMS data files. When the entry of information about the samples is complete, SLIMS generates a Laboratory Service Request form that summarizes the analyses to be performed and the associated Sample-ID. This Laboratory Service Request form is critical. It provides the link between the user's record keeping, the data derived from the analytical instrument, and the information stored in SLIMS.

To analyze a sample the technician begins by invoking a stored SLIMS procedure and identifying the Sample-ID[19] of the sample to be analyzed. At various points in the procedures, the technician enters the requested information (e.g., weight of sample, volume of reagents added, etc.) into SLIMS. Alternatively, the technician can print an analysis worksheet and record the values on the printout, transferring the information to SLIMS later. When the sample preparation is complete and the sample

[18] Personal communication with Jacqueline Sample.

[19] The Sample-ID is assigned to the entire batch of samples. Individual samples within the batch are distinguished by a serial number that is unique within for each Sample-ID.

transferring the information to SLIMS later. When the sample preparation is complete and the sample is ready for analysis, the technician enters the sample identifier (e.g., Sample-ID, Serial Number) into the analytical instrument's data storage, typically in a "comments" field. When the analysis is complete, the instrument writes the results, including the sample identifier, to a disk file. Another stored SLIMS procedure then extracts the sample identifier and the analytical results from this file and stores them, under the Sample-ID, with the data entered earlier for that sample. Once all the data have been entered, SLIMS can generate hard copy and digital reports (e.g., NPDES Discharge Monitoring Report).

Apart from hardware and software issues, some problems encountered using SLIMS derived from management issues. The SLIMS managers at all the shipyards collectively developed the SLIMS procedures. However, the application of these standards was left to the individual shipyards. The extent and success to which they were implemented depended largely on the time, abilities, and motivation of the local SLIMS managers. Some laboratories preferred to use a locally developed procedure and wrote their own SLIMS procedure to process the data. Consequently, the SLIMS configuration is different at each shipyard. This presents configuration management problems for the SLIMS staff in NAVSEA 07Q.

Recommendations

If the chemistry laboratories are to become the primary environmental testing facilities for the shipyards, and if SLIMS is to be the automated record-keeping system for those facilities, then SLIMS should also be the central repository for all shipyard laboratory-derived measurement data. In other words, the data from the laboratory's analytical measurements, including analytical chemistry, bioassay, and so forth, whether performed in-house by the shipyard laboratories or by a contract laboratory, should be stored in SLIMS. Moreover, the SLIMS database should be developed as a component of a larger distributed shipyard environmental database. In this configuration, SLIMS would be responsible for all laboratory measurement, supporting, and associated data. Other shipyard databases would be responsible for field measurements and for other types of supporting and associated data (e.g., sample locations, field methods).

Obviously, this recommendation is a long-term goal. The current interim version of SLIMS cannot accommodate both internal and contract laboratory data. No specification is in place for obtaining the digital data from the contract laboratories. As noted in section 9, the Environmental Divisions at the shipyards are not storing their data in a database that could be linked to SLIMS. Nonetheless, procedural changes can be set in motion now to coordinate the further development of SLIMS and the Environmental Division databases. This will make it possible to interconnect the databases in the future.

Near-Term. Adopting the following changes now or in the near future will lay the groundwork for making SLIMS the central repository for shipyard laboratory measurement data.

- Continue to record as many in-house analytical measurements in SLIMS as possible.
- Explore the feasibility of unloaded data from LAB-SAM® (or LAB/UX) that can be reloaded into the next generation of SLIMS (i.e., Oracle® database). It would be unfortunate if the historical data already in SLIMS was not available through the same interface as future data; in this context, investigate how to associate the QC data recorded in the current versions of SLIMS with the measurement data to which they apply.

- Use the data reporting specification discussed in section to ensure that the data generated by contract analytical laboratories is delivered to the shipyards in fully documented digital form.
- Ensure that, to the extent possible, all procedure manuals, supporting documentation, laboratory certification, QA/QC plans, and regulatory permits are available in digital form. These documents should include those in use today and those used for previous analyses, and should encompass both SLIMS procedures and laboratory analytical methods.
- SLIMS should continue to keep paper files of as much sample-related information as possible. For example, the SLIMS staff currently photocopies the chain-of-custody forms and keeps them in a folder with other information about processing the samples; this will provide one source for information that relates historical SLIMS laboratory data with corresponding field information.

Long-Term. The following recommendations can be initiated now but will take longer to implement.

- Open an exchange with the Environmental Divisions on how to coordinate the development of their separate information management systems. Eventually, the structure of the SLIMS database and the Environmental Divisions' databases should be incorporated into a common data model and database definition. Meanwhile, it is important to ensure that both SLIMS and the Division databases keep track of the one piece of information they share in common—Sample-ID; the two databases should be designed so there is a one-to-one correspondence between field and laboratory sample identifiers. This design will keep a record of the correspondence between field and laboratory sample identifier, and ensure that the identifiers correctly match the associated information in the respective databases. Information maintained separately can be matched in one or the other database, when necessary; eventually, the separate data can be merged into a common database or shared among a distributed database.
- The SLIMS staff should explore with Hewlett Packard® whether mechanisms will be available for applications other than CHEM-LMS to have read and write access to its Oracle® database.
- One gray area between environmental sampling and environmental testing involves the chain-of-custody records. Clearly, the time a sample spends at the testing laboratory and the procedures applied to it belong to the chain-of-custody record. Therefore, the shipyard laboratories need to ensure their record keeping is coordinated with records kept for the samples before they are received and after the data are released.

SUMMARY OF RECOMMENDATIONS

The shipyards' environmental testing laboratories need to accomplish the following:

1. Move away from programmatic compliance and toward an integrated approach based on risk assessment of ecological effects. This shift will require an analytical capability to:
    - Analyze sediment, biological tissues, and water samples;
    - Analyze dissolved, particulate, and total fractions of target compounds;
    - Detect compounds in the low part-per-billion (i.e., *ng/g*) concentration range for all media, including seawater;
    - Reliably recover compounds for all sampled media;
    - Conduct bioassay and biomarker studies;

- Ensure reliable field sampling methods and sample processing.

2. Incorporate Data Quality Objectives and a Data Management Plan as part of project plans for quality assurance.
3. Ensure that all quality control documentation is available in suitable digital form.
4. Retain all quality assurance measurements in a fully documented digital form such that they can be associated with the sample measurements to which they pertain.
5. Be certified by nationally recognized organizations for the accreditation of environmental testing laboratories and require that their contract laboratories be similarly certified.
6. Establish the target SLIMS configuration (i.e., the version based on the CHEM-LMS LIMS software) as the central repository for all shipyard laboratory measurement data, including measurements made by the shipyard laboratories and those made by contract laboratories.
7. Coordinate the development of the SLIMS database with the databases developed by the Environmental Divisions for managing field and related environmental data.

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APPENDIX A
SHIPYARD QUESTIONNAIRE

What is your facility SIC code (standard industrial code)?

PART ONE: GENERAL QUESTIONS

Please rank your primary concerns relating to marine environmental compliance

Water & Sediment Quality Standards:

Are you aware of any establishment or development in progress of sediment quality criteria/standards for your region (i.e., state)?

Is there a failure to attain or maintain applicable water or sediment quality standards, or to protect designated uses in the water body adjacent to your facility, as determined by any federal, state or local regulatory authority? Explain.

Have site-specific water or sediment quality criteria/standards been proposed or instituted at your location?

Shipyard/Regulatory Agency Interface:

Have you been or are you currently in direct violation of any federal, state, or local water or sediment quality standards? Explain and provide any associated documentation (i.e., inspection reports, NCRs = Noncompliance Reports, Notices of Violations).

Have you been required or are you in the process of a Toxicity Reduction Evaluation (TRE)? Please provide details and associated documentation.

Have you been or are you currently (or anticipate being) in any litigation regarding water or sediment quality issues? Explain.

Under which programs has there been any increased regulatory oversight, scrutiny, pressure, or action with respect to water or sediment quality? Explain.

Have any regulators informed you of possible changes with the current situation of regulatory oversight, shifting towards a "multi-media" approach to environmental compliance and permitting?

Characterization of Water Body/Ecosystem:

It is necessary to understand the ecological setting and concerns for the water body adjacent to your shipyard. Briefly explain any concerns of which you are aware (include sensitive ecosystems, endangered/threatened/special concern species and habitats, impacted wetlands, fisheries, shellfish communities, etc): Please provide references.
(Is there a Natural Resources Manager?)

Please list any similar concerns and issues regarding human health (i.e., is the water body fishable? swimmable? are there known or suspected toxic hot spots?): Please provide references.

Have the receiving waters and/or sediment of the adjacent water body been characterized under any non-regulatory monitoring or research program? Please explain and provide references

Specific Contaminants:

Please list the specific contaminant(s) of concern affecting water or sediment quality in the water body adjacent to your facility.

Are there contaminants thought to be migrating from your facility onto nearby non-Navy property?

Are there contaminants thought to be migrating from non-Navy property onto your facility or into an adjacent water body, which may effect water or sediment quality adjacent to your facility?

Programs:

Please check each environmental program listed below under which your shipyard conducts monitoring. For the purpose of this survey, "monitoring" includes sampling, testing, collecting, and reporting of parameters/data/information on a routine, as required (conditional), or one-time basis. Please keep in mind that we are interested only in monitoring that is related to the receiving waters or sediments adjacent to your shipyard.

NPDES Point Source

Non-Point Source/Stormwater

Dredging

CERCLA/Installation Restoration of Hazardous Waste Sites

HSWA/RCRA Corrective Actions for Contaminated Sites

HSWA/UST Past Contamination of Underground Storage Tanks

OTHER: monitoring done under a research study or any other project or program not listed.

Is there any coordination of sampling and analysis between any two or more of the programs you checked above. Please explain briefly the nature of this coordination.

Are there any funding issues or problems for environmental programs within the shipyard? Is there any work that is currently not being accomplished but is necessary or desired to maintain a quality program?

Are there any other environmental management plans and/or regulations that might affect, integrate with, or conflict with each other (e.g., other programs examined under this project, spill prevention and response, air pollution control, OSHA, fire code, and temporary storage of hazardous waste and materials.)

Is the Environmental Division adequately staffed and funded to meet the marine environmental compliance requirements?

Is there any kind of environmental awareness training being done at the shipyard?

Is there a good community public relations program?

Part Two of this questionnaire asks detailed information about the monitoring collected under the specific programs checked above. If you are unsure about any classification, please see the expanded description found in Part Two for the particular program in question. If there is still confusion about this or any other topic in the questionnaire please contact the Marine Environmental Support Office (as per cover letter). This concludes Part One of the questionnaire.

PART TWO: SPECIFIC PROGRAMS

Please answer all questions under each program that applies to your shipyard. Although the federal law or program mandating monitoring requirements has named most programs, please include description of all applicable state and local requirements if they are in addition to federal requirements.

NPDES POINT SOURCE

* This program area refers to the point source monitoring only. If you have stormwater monitoring included in your one NPDES Permit, please discuss the stormwater monitoring in the Non-Point Section.

Term of Permit/Monitoring Program (dates)

Identify the Lead Agency responsible for regulatory oversight and any other federal/state/local agencies which have review authority or are otherwise involved.

Monitoring Program: please provide monitoring plan

List the entities/persons who implement this program:

-Responsible Office, Program Manager, and Navy employee most familiar with program details

-Organization/Contractor that (specify if tasks are split) (1) designs sampling & analysis plan; (2) performs sampling (field collection); (3) conducts laboratory analysis & testing (4) Interprets results

Describe the monitoring program:

-biological/chemical/physical parameters measured

-frequency and location of sampling sites (provide map)

-sampling and analytical methods used (include such notes as to whether minimum detection limits are being met, whether clean/ultra-clean techniques are being used, whether metals are measured by dissolved or total amounts, etc)

-software programs used to write reports/record data and availability expected duration of monitoring program (start & stop dates)

List any other programs to/from which data is provided (shared) and explain.

Please provide copies of all Discharge Monitoring Reports (DMRs)

Permit Requirements:

Has your office been actively involved in establishing the requirements under the Permit? Please explain.

Have you reviewed the Permit's "fact sheet" and "supporting administrative record"? Please provide these documents along with the actual Permit.

What hydrodynamic assumptions or models have been used to derive your Water Quality-based effluent limitations (e.g., Steady State, Continuous Simulation, Stream drought flow [Phil. NSY only])?

How are limitations expressed? Concentrations? Mass Flow? Toxicity? Other?

Have any limitations been established or are being recalculated based on site-specific characteristics of the water body (e.g. Water Effects Ratio, Recalculation [more appropriate species for calculation], Resident Species [rarely used?] procedures as per EPA-600/3-H4-099; Dissolved Criteria as per Prothro Memo)?

Have any mixing zones and/or diffusers been allowed under your Permit? Please explain (i.e., what dilution is allowed?).

Are dry-dock discharges permitted? If not, are dry-dock operations otherwise included in any bilateral agreement between NSY and regulatory agency?

Compliance Status:

Does the Shipyard maintain instructions on Dry-dock Waste Management (e.g., BMPs) or Shipboard Environmental Compliance (i.e. specific for each overhaul)?

Is the shipyard meeting the effluent limitations prescribed by the Permit? If not, please explain (i.e., Are the limits below ambient concentrations? Below detection limits?)
If shipyard operations have been modified to achieve compliance, please describe actions taken (e.g. Best Practicable, Best Conventional, Best Available Technologies as well as Best Management Practices.) Please provide associated documentation.

Have the following strategies been considered: Hydrograph Control Releases, Flow Augmentation (river only), Change in Discharge Location, Trading of Wasteload Allocations?

Have you had to use the Bypass or Upset Procedures? Please explain

Potential Problems/Issues:

Are there inconsistencies between the sampling and analytical methods prescribed by the Permit and those being used by the Navy (e.g. total vs. dissolved metals)? If so, please describe.

Are there inconsistencies between the limits prescribed in the Permit and applicable water quality standards (e.g., use of outdated standards or limits derived from past performance/effluent characterization)? If so, please describe.

Do you believe that the effluent limits are based on incorrect assumptions, inadequate data, or otherwise derived from unsound scientific reasoning (incorrect calculations, wrongful use of drought flow for human health numbers, inappropriate detection limits, improper dispersion models, actual condition of water body different than description in the Permit, etc)? If so, please describe.

Are you aware of other NPDES permittees discharging to the same body of water as your facility but have less stringent discharge limitations than your organization (considering unbalanced Wasteload Allocations, dilution factors, mixing zones, and time allowed to achieve compliance)?

Are there any new or altered input sources expected for your discharges?

Are there any planned activities and/or changes in your operations that will alter the flow of water through your facility?

Is there any monitoring requirement currently or planned for measuring concentrations or toxicity in sediments? Receiving waters?

Is Permit coming up for renewal? If so, has the application gone in 180 days prior to expiration of the current Permit? Are there expected new or modified effluent limits with which the Navy may have problems complying?

Are you aware of any illicit connections?

NONPOINT SOURCE/STORMWATER

* This program area includes non-point pollution monitoring under either the NPDES or the EPA's new Coastal Non-point Pollution Control Program. For the former, please include all monitoring required under construction, industrial, dewatering or municipal general permits as well as requirements incorporated into an existing NPDES permit.

Term of Permit/Monitoring Program (dates)

Identify the Lead Agency responsible for regulatory oversight and any other federal/state/local agencies that have review authority or are otherwise involved. Has the agency reviewed/commented on your program? Is there a high turnover rate with the regulator position?

Monitoring Program: please provide monitoring plan

List the entities/persons who implement this program:

-Responsible Office, Program Manager, and Navy employee most familiar with program details

-Organization/Contractor that (specify if tasks are split) (1) designs sampling & analysis plan; (2) performs sampling (field collection); (3) conducts laboratory analysis & testing

(4) interprets results

Describe the monitoring program:
-biological/chemical/physical parameters measured
-frequency and location of sampling sites (provide map)
-sampling and analytical methods used (include such notes as to whether minimum detection limits are being met, whether clean/ultra-clean techniques are being used, whether metals are measured by dissolved or total amounts, etc)
-software programs used to write reports/record data and availability expected duration of monitoring program (start & stop dates)

List any other programs to/from which data is provided (shared) and explain.

If you are part of a Group Permit and monitoring is required only for some members of our group, please explain the details above.

Were you a part of the Navy's Group Stormwater permit? did you do any testing for it? (Please provide copies of reports)

Is any background sampling of the receiving waters or sediments required under your permit?

Permit Requirements:

How many outfalls have you or the contractor identified and how many are included in your sampling program?

Are there any proposed limits on Stormwater effluents that are being established by local Agencies?

Has your office been actively involved in negotiating (if at all) the requirements under the Stormwater Permit? Please explain.

Do you have a Storm Water Management Plan (with Pollution Prevention Plan SWPPP)? Please provide a copy of the draft or final.

Site Characteristics:

List all applicable categories of non-point source pollution in order of significance including: agricultural runoff; urban runoff; hydro-modification (i.e., re-routing); shoreline erosion; dams; and marinas. Please also list subcategories.

Best Management Practices:

List the management and technology measures (if any) that are being implemented to control the addition of non-point pollutants to coastal waters. List any natural or man-made filtration, retention, or physical separation processes used. (Examples include maintenance areas have any of the following characteristics - designated discrete impervious areas, work areas covered with a roof, upland drainage diversion, source contaminant capturing devices) Provide the BMP Plan or a description of BMPs used for your different locations.

Potential Problems/Issues:

Has there been any regulatory pressure on you regarding the development of the Stormwater program? Which entity has been the driving force?

Do you believe there are any unreasonable requirements in your program?

Are there any local, state, or federally listed habitats in the area of the discharge(s)

List any coastal areas or resources that are threatened by reasonably foreseeable increases in pollution loadings from new or expanding sources.

Are there any illicit connections to the Stormwater system? List outfall #'s and type of flow. (Examples include floor drains, Bleed lines to prevent freezing, blowdown from water heating tanks. This could also include Temporary PWC & Contractor hook-ups.)

Is there any continuous flow to the Stormwater System, especially during dry periods?

Do you have tidal back-flushing of the System? Please provide details.

Do any Storm system discharges affect water quality parameters to levels that cause concern from regulators or other agencies?

DREDGING, FILL AND DISPOSAL

* This program area includes all biological, chemical and physical monitoring of water and sediment prior to, during, and after dredging operations (i.e., Green Book bioassays and analyses, pre-dredging baseline, state-required water quality monitoring, habitat mitigation monitoring, etc)

Term of Permit/Monitoring Program (dates)

Identify the Lead Agency responsible for regulatory oversight and any other federal/state/local agencies which have review authority or are otherwise involved.

Monitoring Program: please provide monitoring plan

List the entities/persons who implement this program:

-Responsible Office, Program Manager, and Navy employee most familiar with program details

-Organization/Contractor that (specify if tasks are split) (1) designs sampling & analysis plan; (2) performs sampling (field collection); (3) conducts laboratory analysis & testing (4) interprets results

Describe the monitoring program:
-biological/chemical/physical parameters measured
-frequency and location of sampling sites (provide map)
-sampling and analytical methods used (include such notes as to whether minimum detection limits are being met, whether clean/ultra-clean techniques are being used, whether metals are measured by dissolved or total amounts, etc)
-software programs used to write reports/record data and availability expected duration of monitoring program (start & stop dates)

List any other programs to/from which data is provided (shared) and explain.

Compliance Status:

Have any dredging operations been affected (e.g. delayed/cancelled) by sediments failing testing for aquatic disposal? Or for any other reasons related to monitoring results? Please explain.

Have you had any problems meeting requirements of NEPA, State Certification, CZMA, ESA, MPRSA, or any other applicable statutes/regulations?

Potential Problems/Issues:

Are there any technical or scientific discrepancies perceived with the testing procedures or permitting process (i.e., use of inappropriate or questionable test species for your particular situation)?

Are there problems with the permitting process with respect to Non-Navy agencies causing delays (e.g. eco-concerns of USFW/NMFS/state agencies) ?

CERCLA/SARA/IR Hazardous Waste Sites

* This program area includes investigation and remediation of past contamination (hazardous waste sites) under CERCLA/SARA and non-NPL "Navy" HW sites, all investigated within the Installation Restoration Program

Term of Permit/Monitoring Program (dates)

Identify the Lead Agency responsible for regulatory oversight and any other federal/state/local agencies that have review authority or are otherwise involved.

Monitoring Program: please provide monitoring plan
List the entities/persons who implement this program:
-Responsible Office, Program Manager, and Navy employee most familiar with program details

-Organization/Contractor that (specify if tasks are split) (1) designs sampling & analysis plan; (2) performs sampling (field collection); (3) conducts laboratory analysis & testing (4) interprets results

Describe the monitoring program:
-biological/chemical/physical parameters measured
-frequency and location of sampling sites (provide map)
-sampling and analytical methods used (include such notes as to whether minimum detection limits are being met, whether clean/ultra-clean techniques are being used, whether metals are measured by dissolved or total amounts, etc)
-software programs used to write reports/record data and availability expected duration of monitoring program (start & stop dates)

List any other programs to/from which data is provided (shared) and explain.

Is your base listed on the NPL or is it proposed for NPL? Is your base listed on any state, regional or local HW list?

At what point (phase) in the IR Process is your facility?

Exactly what are the regulators expectations of your shipyard? Ecological Risk Assessment? Have the regulators given proper guidance?

If there is currently no water or sediment monitoring ongoing or planned, are there hazardous waste sites being investigated under the Installation Restoration program which have the potential for contaminants to migrate to adjacent water bodies?

List any cleanup levels that have been established for any chemicals of concern. Are the levels reasonable? If not, please explain.

Please provide any work plans, data reports, etc. generated under the Installation Restoration Program for sites which may affect water or sediment quality.

HSWA/RCRA Corrective Actions

* This program area includes any monitoring/risk assessment to investigate/characterize SWMUs (Solid Waste Management Units) which have the potential of allowing contaminants to migrate towards an adjacent body of water.

Term of Permit/Monitoring Program (dates)

Identify the Lead Agency responsible for regulatory oversight and any other federal/state/local agencies which have review authority or are otherwise involved.

Monitoring Program: please provide monitoring plan
List the entities/persons who implement this program:
-Responsible Office, Program Manager, and Navy employee most familiar with program details

-Organization/Contractor that (specify if tasks are split) (1) designs sampling & analysis plan; (2) performs sampling (field collection); (3) conducts laboratory analysis & testing (4) interprets results

Describe the monitoring program:
-biological/chemical/physical parameters measured
-frequency and location of sampling sites (provide map)
-sampling and analytical methods used (include such notes as to whether minimum detection limits are being met, whether clean/ultra-clean techniques are being used, whether metals are measured by dissolved or total amounts, etc)
-software programs used to write reports/record data and availability expected duration of monitoring program (start & stop dates)

List any other programs to/from which data is provided (shared) and explain.

If there is currently no water or sediment monitoring ongoing or planned, are there SWMUs being investigated under HSWA/RCRA which have the potential for contaminants to migrate to adjacent water bodies?

At what point in the RCRA Corrective Actions Process is your facility?

List any cleanup levels that have been established for any chemicals of concern. Are the levels reasonable? If not, please explain.

Please provide any work plans, data reports, etc. generated under the Installation Restoration Program for sites which may affect water or sediment quality.

HSWA/UST PAST CONTAMINATION

* This program area refers only to monitoring related to the investigation and/or remediation of "past" soil or sediment contamination resulting from leaking Underground Storage Tanks, as carried out under the Navy's Installation Restoration program.

Term of Permit/Monitoring Program (dates)

Identify the Lead Agency responsible for regulatory oversight and any other federal/state/local agencies which have review authority or are otherwise involved.

Monitoring Program: please provide monitoring plan

List the entities/persons who implement this program:
-Responsible Office, Program Manager, and Navy employee most familiar with program details

-Organization/Contractor that (specify if tasks are split) (1) designs sampling & analysis plan; (2) performs sampling (field collection); (3) conducts laboratory analysis & testing (4) interprets results

Describe the monitoring program:
-biological/chemical/physical parameters measured
-frequency and location of sampling sites (provide map)
-sampling and analytical methods used (include such notes as to whether minimum detection limits are being met, whether clean/ultra-clean techniques are being used, whether metals are measured by dissolved or total amounts, etc)
-software programs used to write reports/record data and availability expected duration of monitoring program (start & stop dates)

List any other programs to/from which data is provided (shared) and explain.

List any cleanup levels that have been established for any chemicals of concern. Are the levels reasonable? If not, please explain.

Please provide any work plans, data reports, etc. generated under the Installation Restoration Program for sites which may affect water or sediment quality.

OTHER

* This program area includes special event-oriented monitoring such as responses to emergencies or spills, under TSCA (for PCBs), National Oil and Hazardous Substances Pollution Contingency Plan/Oil Pollution Act of 1990 (for oil), RCRA (for handling of HW) or HSWA (for storage tanks such as USTs); environmental assessments under NEPA (for pre-construction and major changes in operations); and voluntary (not compliance) monitoring such as research, etc. This program area also includes any other monitoring not previously described.

Term of Permit/Monitoring Program (dates)

Identify the Lead Agency responsible for regulatory oversight and any other federal/state/local agencies which have review authority or are otherwise involved.

Monitoring Program: please provide monitoring plan

List the entities/persons who implement this program:

-Responsible Office, Program Manager, and Navy employee most familiar with program details

-Organization/Contractor that (specify if tasks are split) (1) designs sampling & analysis plan; (2) performs sampling (field collection); (3) conducts laboratory analysis & testing
(4) interprets results

Describe the monitoring program:
-biological/chemical/physical parameters measured
-frequency and location of sampling sites (provide map)
-sampling and analytical methods used (include such notes as to whether minimum detection limits are being met, whether clean/ultra-clean techniques are being used, whether metals are measured by dissolved or total amounts, etc)
-software programs used to write reports/record data and availability expected duration of monitoring program (start & stop dates)

List any other programs to/from which data is provided (shared) and explain.

Have the Natural Resources Management and Oil Spill Response (OPA 90/SPCC) Plans considered sensitive species or habitats? Have these plans been coordinated with the Ecological Risk Assessment?

CHEMISTRY LAB

Is the laboratory certified by the state, EPA, other? For what analyses?

Are Clean or Ultra Clean Techniques used for Trace Metals?

What does the Industrial Laboratory analyze for the NSY? How much is production/HM-MW/environmental ? How much is done in-house and how much is contracted out?

Is the laboratory analyzing any samples collected under environmental programs other than RCRA HM/HW (i.e., IR, NPDES, etc)? If not, is the laboratory prepared to analyze these samples? What staff/resources would be required to fulfill these requirements? Any cost analysis done on this issue?

Is there an operating manual (base instruction) for environmental sampling and/or analysis?

Does the laboratory use test schemes to organize workloads for the different programs?

What is the operating status of the laboratory equipment/spaces?

Review any analytical data forms/custody sheets, etc.

INDUSTRIAL/OILY WASTE PROCESSING

INDUSTRIAL WASTE TREATMENT:

What does the IWTP process for the NSY? Is it certified?
-Types of waste, treatment systems/schemes
-Volume processed (max, min, routinely/monthly)

Where does the IWTP discharge to?

Is the system treating metals to acceptable limits?

Does the IWTP have a chemistry lab? What analyses are done there? Is it certified?

OILY WASTE TREATMENT:

Is there any bilge water treatment plant in operation or being constructed/planned?

Please describe how this system works?

Where does treated effluent and waste go? Is the plant meeting all specified limits, especially for metals?

COMPUTING & DATA MANAGEMENT

Data Sources

Have any of your environmental documents, particularly those that contain the sediment, water, biota, etc. measurement data, been delivered to do you electronically? If so, where are the diskettes with these documents? Do you know what electronic format these documents are in?

Document: WordPerfect, Word, ASCII, etc.

Have you ever received an electronic copy of the data from these studies, separate from the report? If so, where are these data files located and do you know what format they are in?

Data: ASCII (Comma Separated), .DBF (dBASE), Paradox, Access, Oracle

Do you know whether the contractor has reports and/or data available in electronic form for which you only have the hardcopy document? Do you think the contractor would be willing to supply his electronic copy to the Shipyard? For a fee?

n your estimation, what percentage of the monitoring information for your site is available in electronic form? ___%

NRaD Staff: When you get a chance to look at the documents, look to see if they have data reported in tabular form, typically with stations as rows and measurement variables as columns.
PHOTOCOPY DATA EXAMPLES

Are the measurement units reported a) as a column or b) in the header or legend of the table? Are the units something reasonable?

Are the measurement methods adequately described elsewhere in the document and easily associated the measurements variables in the table?

Does the document record who (by name) actually made the measurements (e.g., who measured the fish, who did the grain size, etc.)?

Is the latitude and longitude available for each sampling site? In the measurement table, or in a separate station table? Are seconds recorded as decimal minutes or seconds? How is elevation/depth recorded? Is the tidal datum (e.g., MLLW) reported?

Is the date/time the sample was collected recorded with the measurements? If the samples were collected at a different time than the measurements were performed on that sample, are both the collection and measurement date/times recorded?

Are the QA data (analysis of blanks, spikes, duplicates, standard reference materials) recorded? With the measurements or separately? Are the measurements flagged in the table as to whether they were out-of-bounds?

How are values that are below the detection limits handled? "ND" (not detected)? Blank?

This is probably difficult to distinguish from the hardcopy report, but did they distinguish between "null" values (not measured) and zeros (none present)?

How are sample and subsamples reported? That is, if a core is a sample and if aliquots were extracted from different depths in the core, how are these subsamples linked to the sample from which they came? If field samples are sent to the lab for analysis, are both the field and lab ID numbers recorded or otherwise cross-references?

Are the chain-of-custody data reported for samples that were sent out for analysis?

Is the document printing clear and concise? Could the document be scanned easily?

Do the data tables have lines to separate the columns and/or rows (horizontal and vertical lines sometimes cause heartburn for optical character recognition, OCR, systems)?

Computers & Communications

Please indicate the types of computer and communications equipment in use at the Shipyard Environmental Office:

Desktop Computers

IBM Compatible: ___Pentium ___486 ___386 ___Other (_______________)

___Windows ___DOS ___Other (____________________)

Apple: ___PowerPC ___Macintosh

WordProcessor: ___WordPerfect ___ Word ___Ami Pro

___Other (____________________)

Spreadsheet: ___Microsoft Excel ___Lotus 123 ___Quattro Pro

___Other (_______________________)

Database: ___Paradox for Windows ___Paradox for DOS

___Microsoft Access ___FoxPro ___4th Dimension ___dBASE

___R:Base ___Other (_______________________)

GIS: ___Arc/Info (Need others here)

Other software:

Minicomputers: ___Sun ___DEC Vax ___HP ___Other (_______________)

___Unix ___VMS

Network: ___Novell ___Banyan Vines ___AppleTalk ___Token Ring

___DecNet ___Other (_______________________)

If they are not connected to a LAN, do they know if their building is wired for one?

Communications: ___Modem (Baud: __1200 __2400 __9600 __>9600)

___Ethernet

Information Services ___Internet (Service: __Full __E-mail Only)

___CompuServe

___Other (_______________________)

Can they send electronic mail? Only to other LAN users, or can they send Internet mail (e.g., username@hostname.domain)? What e-mail program do they use (Microsoft Mail. cc:Mail)?

Who is their point-of-contact for computers and/or communications at the Shipyard? Name, phone number, Internet mail address if known.

QUESTIONS FOR NRaD Team TO KEEP IN MIND, NOT FOR QUESTIONNAIRE:

Have any site specific studies been done for your area- either in an EIS or through an Ecological Risk Assessment?

What type of standards or criteria are used to dictate the amounts of discharges in your permits?

Are there any discrepancies between the sampling or analytical methods used to derive the regulatory standards and the methods directed to be used by the present permit?

Are there any established "mixing zones" in the area of your effluents? if so, are there any contaminants that are considered acute and therefore not part of the mixing zone?

What is the relative temperature difference between the receiving waters and the actual discharge? (higher, lower, same)

Which form(s) of conveyance is used in the discharge of effluents? (pipe, ditch, swail, etc..)

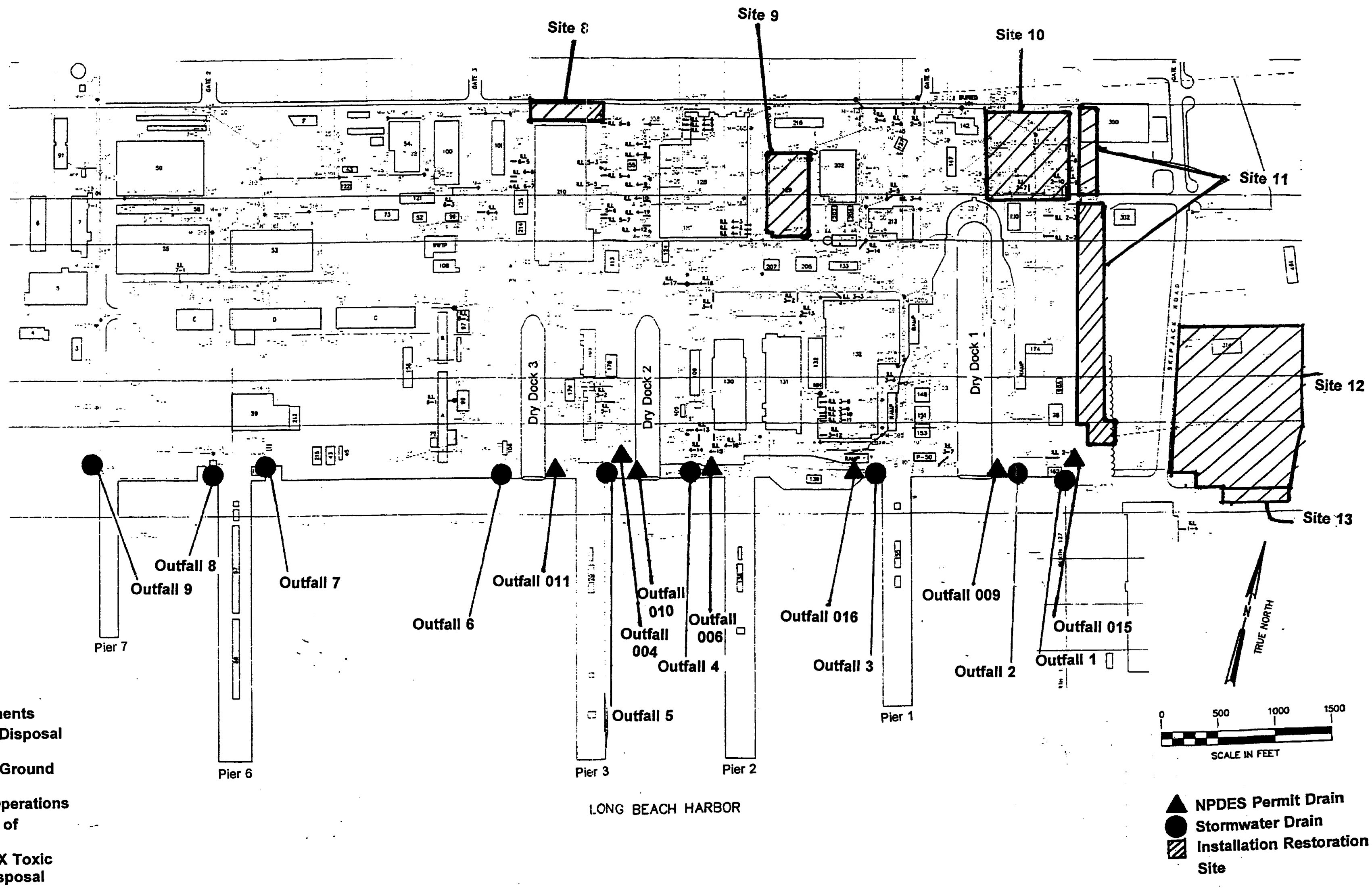
Do your pumping systems or pump heads contain any metallic components (i.e., copper/nickel/bronze piping or fittings)?

NPDES: Do you discharge to a POTW (Publically Owned Treatment Works) or are you a direct discharger?

NONPOINT: Does the drainage from your area drain to an outfall or to a POTW (Publically Owned Treatment Works)

APPENDIX B

REGULATED OUTFALLS AND IR SITE LOCATIONS



Site 7 Harbor Sediments
Site 8 Building 210 Disposal Site
Site 9 Building 129 Ground Floor Spill
Site 10 Lot H Past Operations
Site 11 Hillside East of Drydock 1
Site 12 Parking Lot X Toxic Sandblast Disposal
Site 13 Tank Farm Area near Building 303

Site 7: Long Beach Harbor West Basin

Figure B-1. Long Beach Naval Shipyard

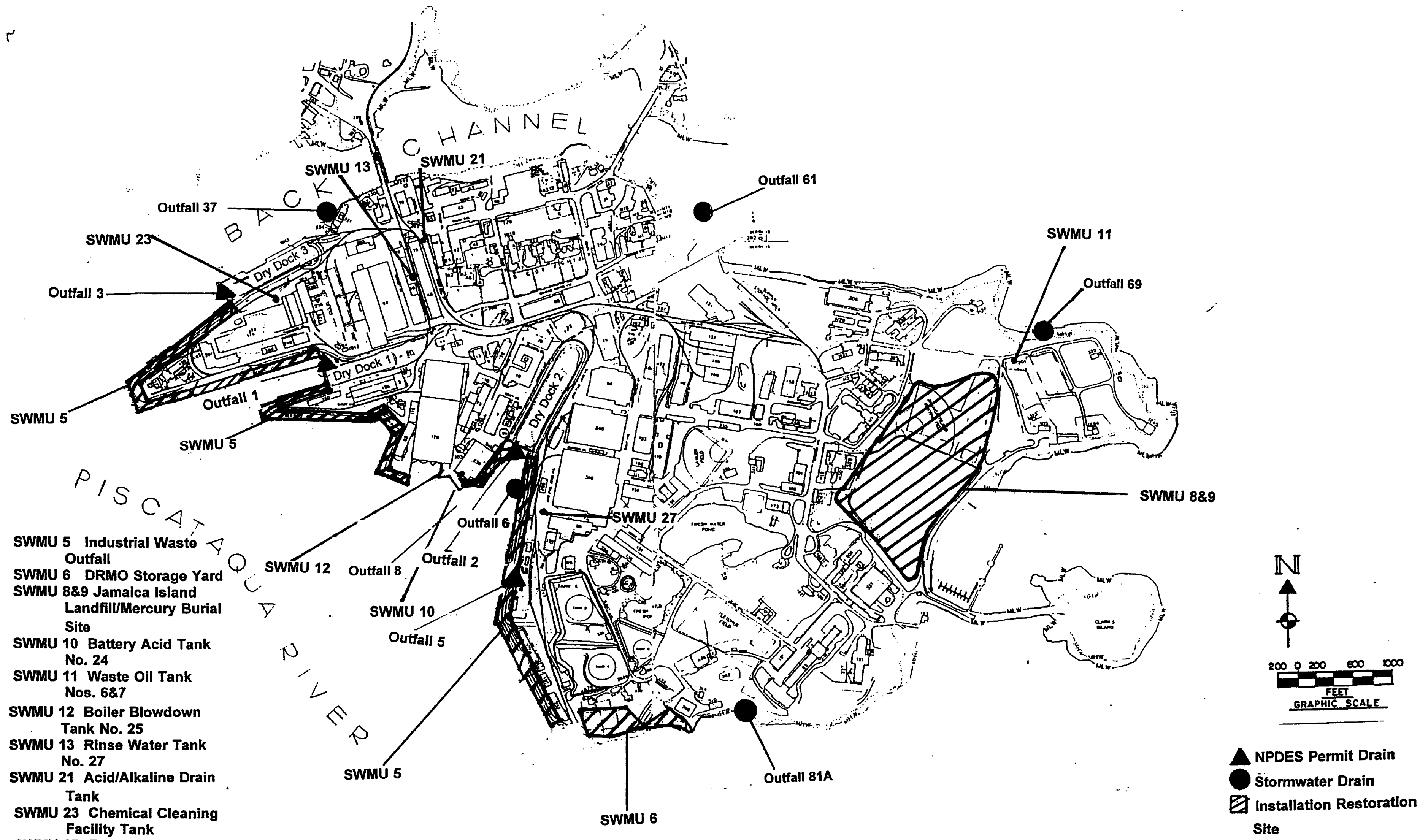


Figure B-2. Portsmouth Naval Shipyard

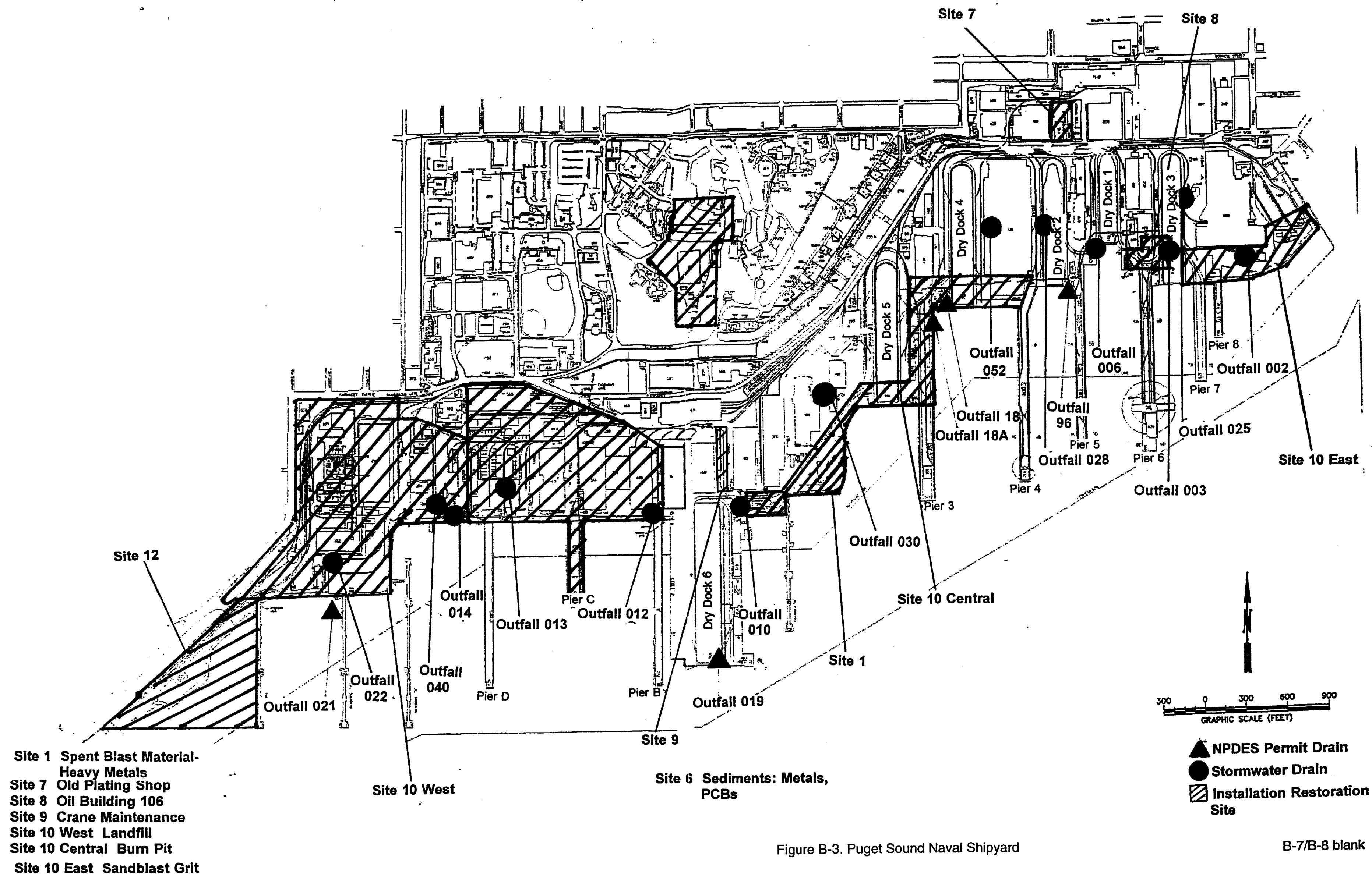


Figure B-3. Puget Sound Naval Shipyard

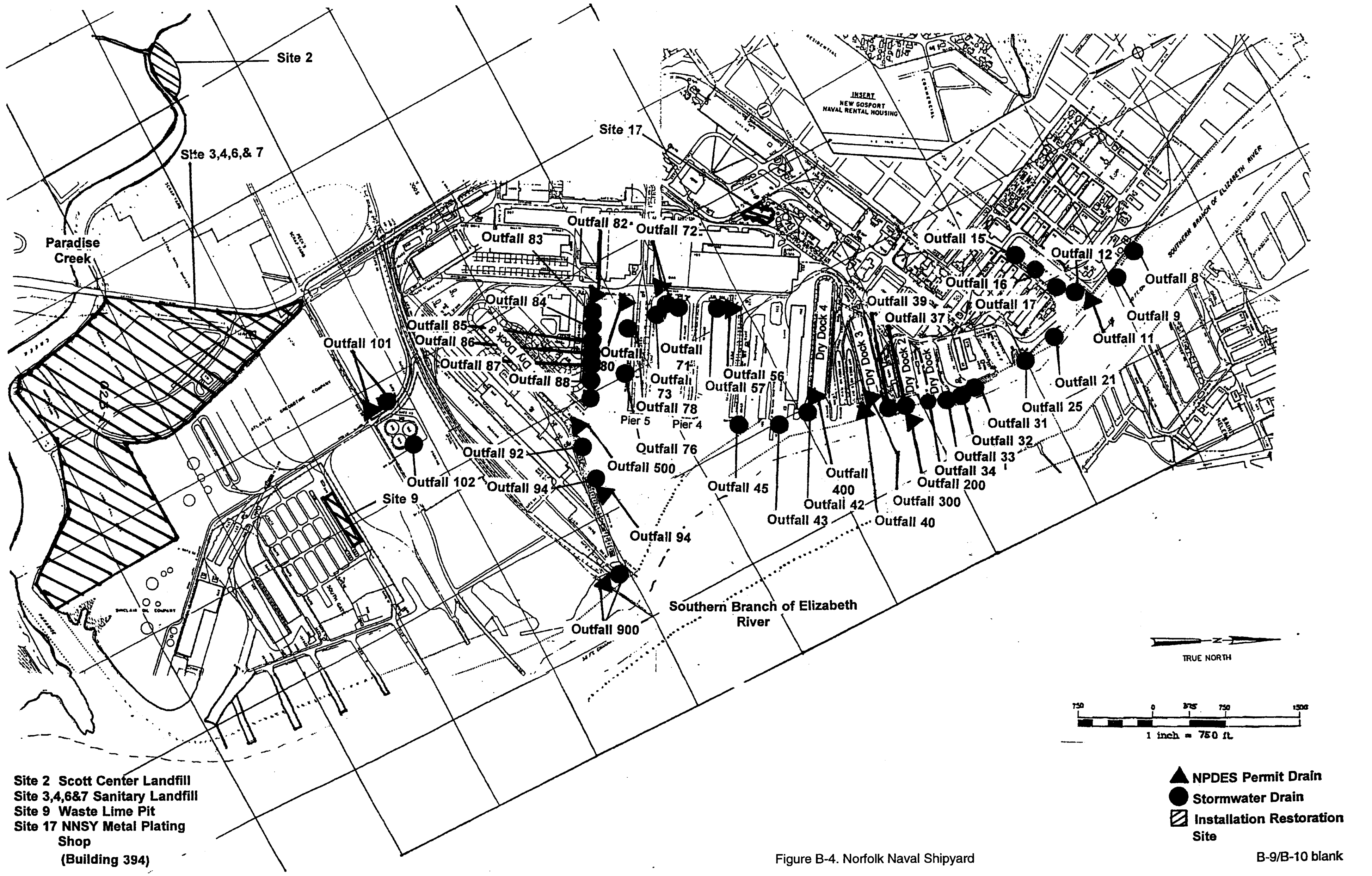
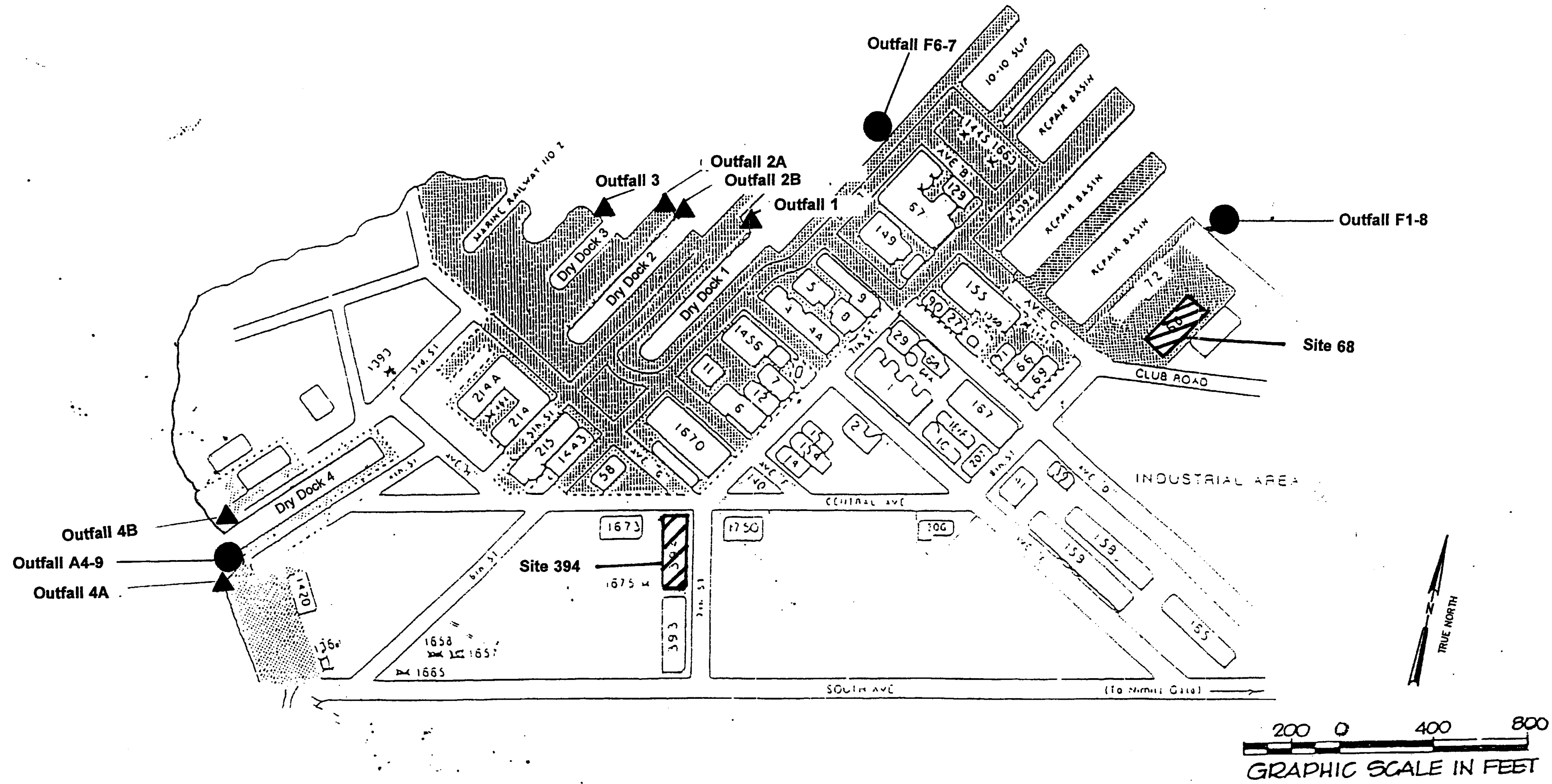


Figure B-4. Norfolk Naval Shipyard



Site 68 PCB Storm Drain
(Building 68)
Site 394 Battery Acid Pit

Figure B-5. Pearl Harbor Naval Shipyard

APPENDIX C
ECOLOGICAL RISK ASSESSMENT

As noted repeatedly elsewhere in this report, EPA and other regulatory agencies have embarked on a shift in focus in environmental regulation, away from environmental quality criteria and towards risk-based assessments. This culminated in the publication in 1992 of the "Framework for Ecological Risk Assessment" (USEPA, 1992; Cohrssen and Covello, 1989). Since then, the term "ecological [or 'environmental'] risk assessment" has been rapidly adopted by the regulatory and the regulated—and recently the political —communities.

One consequence of this rapid shift has been a growing confusion over what is meant by the term "ecological risk assessment." To avoid further compounding this confusion, the following discussion outlines how the term "ecological risk assessment" is used in this report. This discussion was extracted from Munns et al. (1994, pp. 2-5 through 2-9).

APPROACH

The EPA Risk Assessment Forum has developed a "Framework for Ecological Risk Assessment" (USEPA, 1992; Norton, et al. 1992). The framework is intended to provide a logical overarching structure for conducting risk assessments, and to enhance uniformity among assessments. This latter intent is particularly important to decision makers who must evaluate risks associated with various management options, perhaps as estimated by different assessors. The framework is intended to be general with respect to the nature of the stressor(s) and the ecological systems involved in any given assessment. It therefore has utility in assessments involving both chemical and nonchemical stressors, and all types of ecological systems.

The framework itself consists of three major components or steps (figure C-1). During the first of these, Problem Formulation, planning and scoping activities are directed towards delineation of the overall goals, objectives, scope, and activities of the assessment. The Analysis step consists of data collection and modeling exercises to characterize stressor magnitude in time and space, and to define the responses of ecological systems as a result of exposure to the stressor. the methods appropriate for the Analysis step may be stressor-specific, but also depend upon the nature of the ecological systems identified to be at risk. Stressor and effects information are synthesized into estimates of risk in the Risk Characterization step. Ideally, these estimates are quantitative with respect to the level of risk expected under different exposure scenarios. Depending upon the kinds of information available, however, only qualitative estimates of risk may be possible. In addition, an evaluation of the uncertainities and discussion of the assumptions underlying the assessment completes the risk analysis.

Considerations of regulatory requirements, public concerns and constraints (where appropriate), societal values, and other issues relevant to the assessment enter the planning process during Problem Formulation (figure C-1). Data from past and ongoing investigations relevant to the assessment provide additional insight to Problem Formulation. As indicated in this figure, the framework process is intended to be iterative with respect to incorporation of new information and ideas useful in redefining the problem.

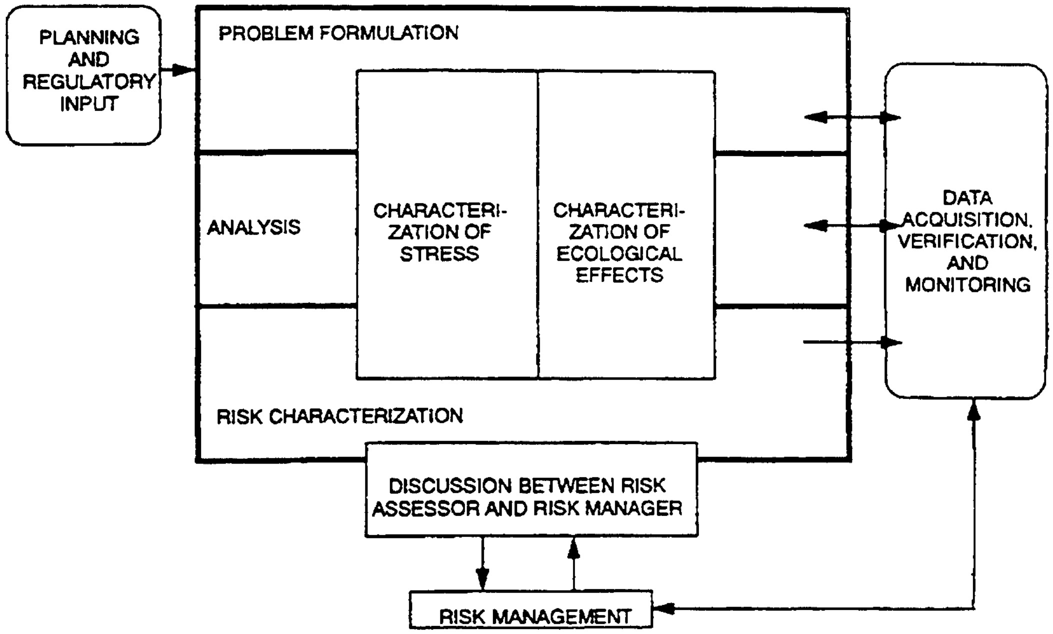


Figure C-1. Framework for ecological risk assessment.

PROBLEM FORMULATION

Defining the problem is the most critical part of an ecological risk assessment. The scope and limitations of the assessment must be established in a way to maximize collection of salient and useful information within available resource constraints. A systematic approach to Problem Formulation (figure C-2) begins with an initial identification of a potential problem. The problem may be formulated by presuming potential risk based upon the characteristics of recognized stressors, or through direct observation of ecological effects in the system. Properties of stressors (e.g., physical and chemical), are directly relevant to defining potential exposure pathways, the temporal and spatial boundaries of the assessment, and ecosystems at risk. Biological properties (e.g., toxicity, community structure) are directly relevant to the type of ecological responses that could be expected and are therefore, appropriate endpoints for use in the assessment. Identification of potential stressors, ecological effects, and ecosystems at risk are the key components to initially define the nature and extent of the problem. Once identified, these considerations lead to selection of endpoints appropriate for evaluation in the assessment. Generally, two types of endpoints can be delineated (Suter, 1990; USEPA 1992): those which symbolize environmental conditions or processes that are valued but which may not be directly quantifiable (assessment endpoints), and those which represent quantifiable indicators of the state of important conditions or processes (measurement endpoints). Criteria important to selection of appropriate assessment and measurement endpoints have been discussed by Suter (1989, 1990, 1992) and others. They generally include considerations of relevancy (with respect to the ecological system, stressor, and societal values), applicability, and utility. Assessment endpoints focus the goals of the assessment on important environmental values.

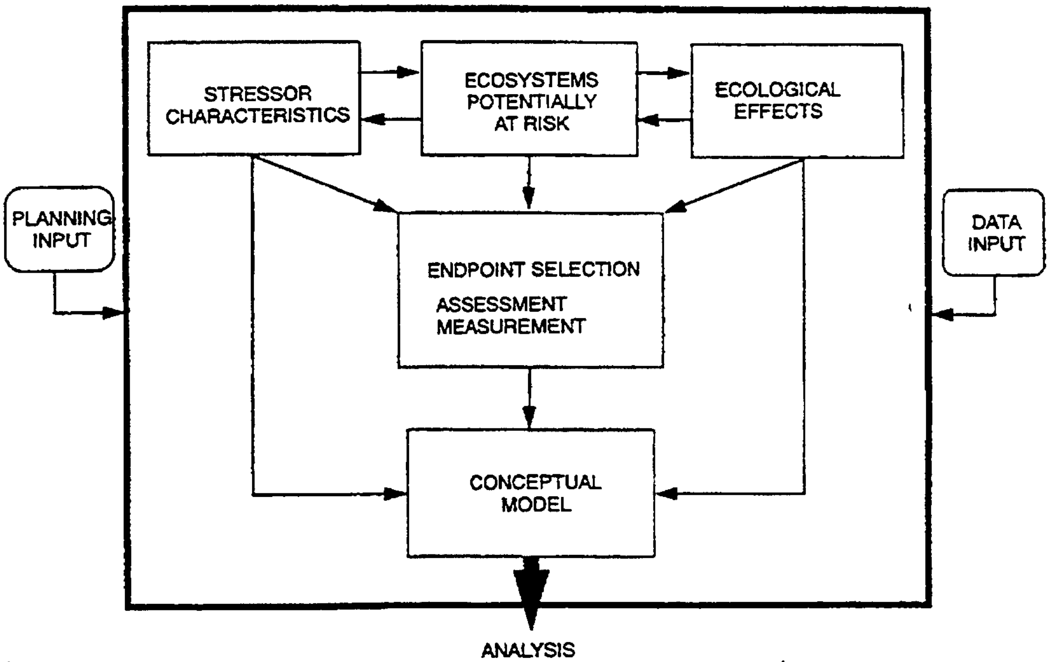


Figure C-2. Problem formulation phase of ecological risk assessment.

Development of a conceptual model, based upon an understanding of the problem, represents the final step in Problem Formulation. This model takes the form of a series of working hypotheses describing the origin, transport, fate, and ecological effects of the stressor. It defines the scope of the assessment, bounds the spatial and temporal scales of investigation, delineates potentially affected ecosystems, and identifies key measurement and modeling activities for the subsequent analysis. The conceptual model also describes the relationship of measurement endpoints to assessment endpoints. Ideally, the conceptual model should undergo rigorous review by risk managers, scientific peers, and the public to ensure that all concerns have been addressed, and that the assessment will yield a scientifically sound and credible analysis of risk.

ANALYSIS

Evaluating the significance of exposure to ecological effects is the goal of Analysis. Two parallel lines of investigation take place in an interactive fashion: characterization of exposure, and characterization of ecological effects. These analyses ultimately lead to development of profiles describing stressor exposure and the responses of ecological systems to that exposure. The analysis seeks to develop relationships between incremental increases in stressor to incremental increases in ecological responses. Interaction between exposure and effects analyses helps ensure that the profiles are compatible and can be integrated into statements of risk.

Exposure characterization involves quantification of stressor patterns with respect to magnitude, temporal duration and frequency, and spatial scale of occurrence in the environment. Typically, measurement and/or modeling activities are used to define these patterns. Measurement activities may involve attempts to directly quantify the stressor through field sampling programs, or may involve use of indicators of exposure (such as exposure biomarkers). Although generally associated with a greater degree of uncertainty, modeling exercises can be used to predict exposure conditions

which cannot readily be measured. Models also permit enhanced understanding of the processes involved in determining stressor patterns, and prediction of patterns under different exposure scenarios.

Attributes of the stressor and of the ecosystem (biotic and abiotic) both influence exposure. Such considerations are particularly cogent when defining the spatial and temporal pattern of occurrence between the stressor and the particular ecological system of interest (e.g., individual organisms, communities, etc.), and therefore the potential for exposure. For example, a metal contaminant may be measured or predicted to occur in depositional sediments, but sediment characteristics (e.g., high acid volatile sulfide) may inhibit metal bioavailability to benthic species.

Ecological effects are quantified by determining the relationships between relevant exposure patterns and resulting responses of ecological systems, in terms of the measurement endpoints identified during Problem Formulation. As with analyses of exposure, both measurement and modeling activities are useful in this process. Several approaches may be used to establish effects profiles, ranging from identification of toxicity thresholds (e.g., sediment and water quality criteria, LC50s, etc.), to development of stressor-response models. This latter approach relates the degree of response observed in the measurement endpoint to the level of exposure experienced by the target system. They provide a means of quantifying effects over a range of exposures, incorporating natural variability in response thresholds, and establishing evidence for causal relationships (source stressor exposure effect). Stressor-response models can be developed from available data, or generated in the course of laboratory and/or field investigations.

Throughout the Analysis step, attention should be given to the uncertainties associated with estimates of exposure and effects. This information provides the basis for determining the degree of confidence to be associated with analysis results, and helps to identify gaps in the understanding of environmental processes.

RISK CHARACTERIZATION

The final step ecological risk assessment involves synthesis of the exposure and ecological effects information to determine the likelihood of occurrence of adverse ecological effects. Depending upon the nature of information obtained and types of analyses conducted, estimates of risk may be either qualitative or quantitative. Examples of qualitative assessments include those which compare single estimates of exposure to an ecological benchmark concentration (water quality criterion). If the ratio of the two exceeds some predetermined level (typically 1.0), a presumption of risk is concluded. Although widely used when more detailed exposure and effects information is lacking, such quotient methods (Barnthouse et al., 1986) offer little in the way of evaluating the probability that an adverse effect has or will occur. Moreover, risk quotients lack a means of evaluating the incremental changes in exposure (i.e., remediation).

More desirable approaches to quantifying risk include those which compare distributions of exposure and ecological responses. When risk is defined simply as the joint probability of exposure and effects, these methods incorporate variability in both stressor concentration and ecological response. In expressing risk as a probability (between 0 and 1), they also obviate the problems associated with open ended risk quotients. Another accepted approach to estimating risk involves simulation modeling. This approach incorporates knowledge of ecological processes directly into risk quantification, and can utilize information regarding both variability and uncertainty in parameter estimates. Probabilistic estimates also result from this method of risk characterization.

Regardless of the approach taken to estimate risk, some form of uncertainty analysis should be conducted prior to communicating assessment results to the risk manager. This analysis provides insight to the degree of confidence that should be associated with the estimate of risk. It also serves to evaluate the effects of uncertainty on the entire assessment, and ideally identifies approaches that can be taken to reduce uncertainty. Uncertainty analysis often leads to additional research to enhance understanding of environmental processes and systems.

APPENDIX D

RESPONSE TO COMMENTS RECEIVED FROM NAVAL SHIPYARDS

Comment: *How will the Navy attain the objective "to gain an understanding of all sources of pollutants into the water body and their relative contributions to the total input?" For this to have an impact on determining what a shipyards regulatory requirements are, it will require agreement from regulatory agencies (federal, state and local) and other private parties and municipalities contributing pollutants to the water body.*

Response: In the short term, it is the intention of the Integrated Marine Environmental Compliance Program (IMECP) to assess available information for a Shipyard's specific water body. NRaD will work with NSYs to collect non-Navy data/reports/ assessments on the aquatic ecosystem. This is part of Phase III and in preparation for the long-term Monitoring Programs that will be developed under Phase IV.

In the long term, a watershed approach should be taken. The U.S. Navy must work together with other stakeholders to contribute to the effort for a full understanding of the aquatic environment. This approach would focus on entire areas and involve multiple participants to describe and better understand the regional environment.

Comment: *The document discusses improving communication with regards to regulatory issues and data gathered from various programs. The IR program at the shipyards is or will be a large part of the existing or initial data gathering efforts. Despite this, the role of the EFDs has been ignored in the IR program. This report should be expanded to discuss the EFD's role.*

Response: The role of the EFDs has not been ignored in the development of this project. Their participation will enhance its success. However, this project is supported by and coordinated with NAVSEA personnel. Any statement of NAVFAC's role in these efforts would be premature at this time. Once the recommendations of the Phase I report has been approved, other entities will be consulted and incorporated.

Comment: *As the title of the report suggests, the effort proposed by NRaD will attempt to integrate various environmental programs at Naval Shipyards. Programs which discharge or have the potential to discharge pollutants into the water bodies surrounding the shipyards are those considered in this report. Funding sources for these various programs have different statutory and programmatic limitations. For an integrated approach, such as this, to be successful it must recognize these limitations up front and work with the various program managers to integrate the funding sources as well.*

This program is set up to address MESO "projected" regulatory requirements/ trends which are ecosystem risk based; these differ from current requirements which the Shipyards are in compliance with. These changes in

philosophy/requirements are more national/regional issues (i.e. will require legislative changes), which means portions of the work in the proposal are not current "compliance" work.

Response: Until funding can be identified, we recommend performing pieces of the work through the current funding structure (i.e., NPDES, stormwater, dredging, etc.). MESO acknowledges that any cost sharing for efforts spanning two or more programs would require flexibility and approval on the part of Shipyard (and perhaps NAVSEA) managers and administrators.

Comment: *It has been our experience at the shipyard, that as data is managed at a more finite level, as the report recommends, additional staffing will be required. This has proven to be the case with data input and management in similar programs.*

Response: Yes, additional staffing for computer and communications support will likely be required. However, MESO believes this will be a shift of resources, rather than simply adding resources. Cost savings from more efficient data processing, re-use of data from previous and concurrent studies, etc. will, in our estimation, offset the cost of hardware, software, and personnel to support these services.

Comment: *Our major concern is that significant efforts and funds should not be committed to risk assessment based limitations until it can be shown that this approach will be used at federal and local levels. Does NRaD have any indication as to the status of risk assessment acceptance by federal and local agencies?*

Response: MESO believes that current trends to re-invent government and to reform regulatory programs provide an optimal climate for regulators to allow our approach, based on its scientific validity and innovative nature. It will not be necessary to have the approach implemented nationally or even regionally. It is only necessary to obtain approval for demonstration and implementation at each Shipyard by its respective regulatory authorities.

Comment: *The report mentions performance of additional sampling and analysis associated with establishing a database to allow risk assessment based permit limits. While it may be that risk assessment based limits allowed in the future, presently water quality and technology based limits are used in permit development. Is separate funding justified/available for the performance of this additional sampling? Presently, funding is available for only existing requirements. Is the time and expense of processing additional samples warranted when it is not known if risk assessment can be used in permit formulation at not only a federal level, but also state or local level?*

Response The shipyards on an individual basis have already intimated some additional sampling. Norfolk has started efforts in dilution modeling for mixing zones, and water effects ratios and chemical translators for more realistic permit limits. Pearl Harbor is having a contractor re-derive their permit limits to provide some relaxation from existing requirements. As we proceed from these near-field studies to broader water body and watershed studies, it will be important to involve all stakeholders (e.g. municipalities, industries, etc.) within a contributory-based funding structure. Such efforts have been proposed by Advisory Task

Forces who are working on California's new water quality policy (Inland Surface Waters and Enclosed Bays and Estuaries Plans).

Comment: *Much of the focus of IMECP is water data collection and interpretation. We agree that all the water quality information collected at shipyards should be collected and organized. Presently all shipyards have systems by which they manage their data. These systems were developed specifically to suit the needs of additional shipyard and are continuously updated based on regulator comments and additional requirements. Any proposed systems used should have this feature.*

Response: The data collection and organization efforts at the shipyards will not affect the manner in which data is currently used. Only the manner in which it is stored will be changed—to improve its accessibility and expand its application across several Shipyard environmental programs.

Comment: *Any NRaD-suggested improvements that require reopening of permits must be weighed against the value added of this reopener. The time and effort spent should be more than justified for this to be considered.*

Response: In general, we recommend using permit modifications rather than permit reopeners. Permit modifications allow changes to be made without re-opening the formal review period for the public.

Comment: *To put the integrated program into effect will require significant resources and high-level buy-in from management and regulators. Regulator buy-in should not be too difficult as long as the shipyards provide, at least initially, higher quality information in preexisting and already accepted formats. Management buy-in seems a much more complex and crucial issue. Related to management buy-in, there is concern about the general difficulty of implementing and maintaining any initiative that involves computers.*

Response: High-level buy-in from both shipyard management and regulatory agencies is essential for the success of this program. The implementation of recommendations from the Phase I report will be tailored to meet the needs of each individual shipyard. The priorities at each shipyard will differ based on its own compliance status and regulatory climate. MESO is now working with the shipyards and NAVSEA to develop a plan to receive approval from higher Navy echelons and local and national regulatory authorities to implement the IMECP. MESO is also working with CNO to formulate a Navy-wide policy regarding environmental data management and the computer and communications resources this will require.

APPENDIX E
ABBREVIATIONS AND ACRONYMS

A2LA	The American Association for Laboratory Accreditation
AA-GF	Atomic Absorption - Graphite Furnace
ACoE	Army Corps of Engineers
ACS	American Chemical Society
AOE	Navy Oiler
ASTM	American Society for Testing and Materials
BAIM	Baseline Advanced Industrial Management
BMPs	Best Management Practices
BOWTS	Bilge and Oily Waste Treatment System
BPA	Buyer Purchase Agreement
BPT	Best Practicable Control Technology
BPJ	Best Professional Judgment
BRAC	Base Realignment and Closure
CASE	Computer-Aided Software Engineering
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CHT	Collection Holding Tank (Shipboard Sewage)
CLEAN	Comprehensive Long-term Environmental Action Navy
CNO-N45	Chief of Naval Operations (code 45)
CO	Commanding Officer
COD	Chemical Oxygen Demand
COTS	Commercial Off-the-Shelf
CSO	Combined Sewer Overflow
CTD	Conductivity, Temperature, Depth
CVN	Aircraft Carrier- Nuclear Powered

CWA	Clean Water Act
DAF	Dissolved Air Flotation
DDT	Dichloro Diphenyl Trichloroethane
DEP	Department of Environmental Protection
DEQ	Department of Environmental Quality
DERA	Defense Environmental Restoration Account
DLA	Defense Logistics Agency
DM	Dissolved Metals
DMP	Data Management Plan
DMR	Discharge Monitoring Report
DOH	Department of Health
DQO	Data Quality Objectives
DTS	Department of Toxic Substances Control
DYNHYD3	Dynamic hydrodynamic model, version 3
ECE	Environmental Compliance Evaluation
EFA	Engineering Field Activity
EFD	Engineering Field Division
EIS	Environmental Impact Statement
E-MAIL	Electronic Mail
EPA	Environmental Protection Agency
ERA	Ecological Risk Assessment
ERD	Entity-Relationship Diagram
ER-M	Effects Range- Median (under NOAA NS&T program)
FFA	Federal Facilities Agreement
FGDC	Federal Geographic Data Committee
FIPS	Federal Information Processing Standard

GC-MS	Gas Chromatography - Mass Spectroscopy
GIS	Geographic Information System
GOSIP	Government Open Systems Interconnect Profile
GOTS	Government Off-the-Shelf
GPD	Gallons per Day
GPM	Gallons Per Minute
HRS/NPL	Hazard Ranking System/National Priority List
HRSD	Hampton Roads Sanitation District
HSWA	Hazardous & Solid Waste Amendments (to RCRA)
ICP/MS	Inductively Coupled Plasma/Mass Spectroscopy
IPI	Industrial Process Instruction
IR	Installation Restoration
IWTP	Industrial Wastewater Treatment Plant
LAC	Laboratory Advisory Council
LAN	Local Area Network
LANTDIV	Atlantic Division NAVFAC
LBNSY	Long Beach Naval Shipyard
LIMS	Laboratory Information Management System
MBARI	Monterey Bay Aquarium Research Institute
MDL	Method Detection Limit
MESO	Marine Environmental Support Office
MGD	Million Gallons per Day
MILCON	Military Construction Project
MTCA	Model Toxics Control Act

NAVFAC	Naval Facilities Engineering Command
NAVSEA	Naval Sea Systems Command
NAVSTA	Naval Station
NCCOSC	Naval Command, Control and Ocean Surveillance Center
NCEL	Naval Civil Engineering Laboratory
NCP	National Contingency Plan
NEDTS	Navy Environmental Data Transfer Standards
NEPA	National Environmental Policy Act
NFESC	Naval Facilities Engineering Service Center
NNSY	Norfolk Naval Shipyard
NOAA	National Oceanographic and Atmospheric Administration
NOI	Notice of Intent
NOV	Notice of Violation
NPDES	National Pollutant Discharge Elimination System
NPL	National Priority List
NRaD	Naval Command, Control and Ocean Surveillance Center, Research Development Technology and Evaluation Division
NRMP	Natural Resource Management Plan
NSDI	National Spatial Data Infrastructure
NSLAP	Naval Shipyard Laboratory Accreditation Program
NSY	Naval Shipyard
NS&T	National Status and Trends Program under NOAA
OCR	Optical Character Recognition software
O/F	Outfall
O&G	Oil and Grease
OHS	Oil and Hazardous Substances
OPA	Oil Pollution Act of 1990
OU	Operable Unit (Under IR Program)
OWS	Oil-Water Separator
OWTP	Oily Waste Treatment Plant

OWTS	Oily Waste Treatment System
PAH	Polycyclic Aromatic Hydrocarbon
PC	Personal Computer
PCB	Polychlorinated Biphenyl
PHNSY	Pearl Harbor Naval Shipyard
PNSY	Portsmouth Naval Shipyard
POAM	Plan of Action & Milestones
POC	Point of Contact
POSIX	Portable Operating System Interface
POTW	Publicly Owned Treatment Works
ppb	Parts per Billion
ppm	Parts per Million
ppt	Parts per Trillion
PSDDA	Puget Sound Dredge Disposal Authority
PSNSY	Puget Sound Naval Shipyard
PWC	Public Works Center
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RAB	Restoration Advisory Board
RAM	Random Access Memory
RCRA	Resource Conservation and Recovery Act
RDBMS	Relational Database Management System
RDF	Refuse-Derived Fuel
RFI	Remedial Field Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RWQCB	Regional Water Quality Control Board (California)

SCE	Southern California Edison
SCR	Site Characterization Report
SDSC	San Diego Supercomputer Center
SETAC	Society of Environmental Toxicologists and Chemists
SI	Site Investigation
SIMM	Single In-line Memory Module
SLIMS	Shipyard Laboratory Information Management System
SMTP	Simple Mail Transfer Protocol
STP	Sewage Treatment Plant
SWDIV	Southwestern Division of NAVFAC
SOP	Standard Operating Procedure
SOW	Statement of Work
SPCC	Spill Control and Countermeasures
SRM	Standard Reference Material
SWMU	Solid Waste Management Unit
SWPPP	Stormwater Pollution Prevention Plan
STP	Sewage Treatment Plant
TAL	Target Analyte List
TBT	Tributyltin
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TCP/IP	Transmission Control Protocol/Internal Protocol
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
TOXIWASP	Toxicological Water Analysis Simulation Program (dispersion model)
TPH	Total Petroleum Hydrocarbons
TRC	Total Recoverable Copper
TRE	Toxicity Reduction Evaluation
TRM	Total Recoverable Metal
TSS	Total Suspended Solids

TSSDS	Tri-service Spatial Data Standard
USCG	United States Coast Guard
USF&W	United States Fish and Wildlife
UST	Underground Storage Tanks
VOC	Volatile Organic Compound
WET	Whole Effluent Toxicity
WER	Water Effects Ratio
WQS	Water Quality Standards
WWW	World Wide Web

APPENDIX F
GLOSSARY

A

Absorption - The passage of one substance into or through another (Government Institutes, 1990).

Acute - refers to a stimulus severe enough to rapidly induce an effect; in aquatic toxicity tests, an effect observed in 96- hours or less is typically considered acute. When referring to aquatic toxicology or human health, an acute affect is not always measured in terms of lethality (USEPA, 1994).

Acute toxicity - any poisonous effect produced within a short period of time following exposure, usually up to 24-96 hours, resulting in severe biological harm and often death (Government Institutes, 1990)

Ambient - Environmental or surrounding conditions (Government Institutes, 1990)

American Standard Code for Information Interchange (ASCII) - The predominant character set encoding of present-day computers. The modern version uses 7 bits for each character, whereas most earlier codes (including an early version of ASCII) used fewer. Typically, when people refer to "ASCII data" they mean computer-readable files that do not contain any special internal character codes, just the "printable" letters, numbers, carriage return, line feed, etc. URL: http://wombat.doc.ic.ac.uk/

Analysis - used in two different ways in this report: (1) measurement of biological, chemical, or physical parameters in a laboratory; or (2) process of evaluating issues or problems. The context in which they are used should easily distinguish between the two.

ASCII - see American Standard Code for Information Interchange

Averaging Period - is the period of time over which the receiving water concentration is averaged for comparison with criteria concentrations. This specification limits the duration of concentrations above the criteria (USEPA, 1994).

Average monthly discharge limitation - The highest allowable average of "daily discharges" over a calendar month, calculated as the sum of all daily discharges measured during a calendar month divided by the number of daily discharges measured during that month (Government Institutes, 1990).

Average weekly discharge limitation - The highest allowable average of "daily discharges" over a calendar week, calculated as the sum of all daily discharges measured during a calendar week divided by the number of daily discharges measured during that week (Government Institutes, 1990).

B

Background level - with respect to water pollution, amounts of pollutants present in the ambient water due to natural sources (Government Institutes, 1990).

Batch - The collection of a substance or a product of the same category or configuration, as designated by the Administrator in a test request, from which a batch sample is to be randomly drawn and inspected to determine conformance with acceptability criteria (Government Institutes, 1990).

Benthic Organism - A form of aquatic plant or animal life that is found on or near the bottom of a stream, lake or ocean (Government Institutes, 1990).

Best Available Control Technology - An emission limitation based on the maximum degree of reduction of each pollutant subject to regulation achievable taking into account energy, environmental, and economic impacts and other costs (Government Institutes, 1990).

Best Available Technology - The best technology, treatment techniques, or other means that is available (Government Institutes, 1990).

Best Management Practices - A practice, or combination of practices, that is determined by a State after problem assessment, examination of alternative practices, and appropriate public participation to be the most effective, practicable means of preventing or reducing the amount of pollution generated by non-point sources to a level compatible with water quality goals (Government Institutes, 1990).

Bilge oil - Waste oil which accumulates, usually in small quantities, in the lower spaces in a ship, just inside the shell plating. Usually mixed with larger quantities of water (Government Institutes, 1990).

Bioaccumulation - is the process by which a compound is taken up by an aquatic organism, both from water and through food (USEPA, 1994).

Bioaccumulative - A characteristic of a chemical species when the rate of intake into a living organism is greater than the rate of excretion or metabolism. This results in an increase in tissue concentration relative to the exposure concentration (Government Institutes, 1990).

Bioassay - is a test used to evaluate the relative potency of a chemical or a mixture of chemicals by comparing its effect on a living organism with the effect of a standard preparation on the same type of organism. Bioassays are frequently used in the pharmaceutical industry to evaluate the potency of vitamins and drugs (USEPA, 1995).

Bioavailability - is a measure of the physicochemical access that a toxicant has to the biological processes of an organism. The less the bioavailability of a toxicant, the less its toxic effect on an organism. (USEPA, 1994)

Biochemical Oxygen Demand - The dissolved oxygen required to decompose organic matter in water. It is a measure of pollution because heavy waste loads have a high demand for oxygen (Government Institutes, 1990).

Bioconcentration - is the process by which a compound is absorbed from water through gills or epithelial tissues and is concentrated in the body (USEPA, 1994).

Biodegradation - the breaking down of substances by microbiological organisms such as bacteria and fungi.

Biological Criteria - are narrative expressions or numeric values of the biological characteristics of aquatic communities based on appropriate reference conditions. As such, biological criteria serve as an index of aquatic community health. It is also known as biocriteria (USEPA, 1994).

Biological Monitoring - describes the use of living organisms in water quality surveillance to indicate compliance with water quality standards or effluent limits and to document water quality trends. Methods of biological monitoring may include, but are not limited to, toxicity testing (such as ambient toxicity testing or whole-effluent toxicity testing) and biological surveys. It is also known as biomonitoring (USEPA, 1994).

Biomagnification - is the process by which the concentration of a compound increases in species occupying successive trophic levels (USEPA, 1994).

Biotic - major, extensive and regional collection for plants and animals, often extending over vast geographical areas. (*Pratt*, 1995)

Bioturbation - the process in which burrowing aquatic organisms stir up sediments and other materials existing at the bottom of a water body. Can cause resuspension of sediments and any associated contaminants (see also resuspension).

Blowdown - The minimum discharge of recirculating water for the purpose of discharging materials contained in the process, the further buildup of which would cause concentrations or amounts exceeding limits established by best engineering practice (Government Institutes, 1990).

By-pass - The circumventing of a particular portion of a process or pollution control system (Government Institutes, 1990).

C

Caisson - A wood, steel, concrete or reinforced concrete, air- and water-tight chamber in which it is possible for men to work under air pressure greater than atmospheric pressure to excavate or work with material below water level (Government Institutes, 1990).

Calibration - The set of specifications, including tolerances, unique to a particular design, version or application of a component or component assembly capable of functionally describing its operation over its working range. (Government Institutes, 1990).

Calibration error - The difference between the pollutant concentration indicated by the measurement system and the known concentration of the test gas mixture (Government Institutes, 1990).

Carcinogen - any probable or known cancer-causing agent in humans.

Chronic - defines a stimulus that lingers or continues for a relatively long period of time, often one-tenth of the life span or more. Chronic should be considered a relative term depending on the life span of an organism. The measurement of a chronic effect can be reduced growth, reduced reproduction, etc., in addition to lethality (USEPA, 1994).

Clarifier - A settling tank where solids are mechanically removed from waste water (Government Institutes, 1990).

Cleanup - Actions taken to deal with a release or threat of release of a hazardous substance that could affect humans and/ or the environment. The term "cleanup" is sometimes used interchangeably with the terms remedial action, removal action, response action, or corrective action (Government Institutes, 1990).

Client-Server - A software partitioning paradigm in which a distributed system is split between one or more server tasks which accept requests, according to some protocol, from (distributed) client tasks that are asking for information or action. There may be either one centralized server or several distributed ones. This model allows clients and servers to be placed independently on nodes in a network. See URL: http://wombat.doc.ic.ac.uk/

Combined sewers - A sewer system that carries both sewage and storm water runoff. Normally, its entire flow goes to a waste treatment plant, but during a heavy storm, the storm water volume may be so great as to cause overflows. When this happens untreated mixtures of stormwater and sewage may flow into receiving waters. Storm water runoff may also carry toxic chemicals from industrial areas or streets into the sewer system (Government Institutes, 1990).

Community - collection of interacting populations in an area; a naturally occurring collection of different species (*Pratt*, 1995).

Complexation - the process of a metal or chemical combining with a dissimilar compound or material to produce a larger molecular structure. This binding process often changes the behavior or toxicity of one or more of the individual components.

Contaminant - Any physical, chemical, biological, or radiological substance or matter that has an adverse affect on air, water, or soil (Government Institutes, 1990). In this report, used interchangeably with pollutant.

Continuous discharge - A "discharge" which occurs without interruption throughout the operating hours of the facility, except for infrequent shutdowns for maintenance, process changes, or other similar activities (Government Institutes, 1990).

Criteria - are elements of State water quality standards, expressed as constituent concentrations, levels, or narrative statements, representing a quality of water that supports a particular use. When criteria are met, water quality will generally protect the designated use (USEPA, 1994).

D

Database - A collection of stored operational data used by the applications systems of some particular enterprise (Date, 1995).

Database Management System (DBMS) - The software which handles all access to the data in a database (Date, 1995).

Data Model - Typically, a diagram which shows the natural structure of a database. A *conceptual* data model captures the overall structure of an organization's data, while being independent of any particular model type which might be used to implement that structure. A *logical* data model translates the structure into the organization of a particular class of data model (e.g., relational, hierarchical, or network). A *physical* data model represents the structure in terms a specific DBMS (e.g., Oracle, Sybase, Access). The most commonly used data modeling method is the Entity-Relationship (E-R) model. Data models can also represent the flow of data from one process to another (e.g., Data Flow Diagrams, or DFDs).

Data Reporting Specification - instructions on how to organize data values into a standard format so they can be read by a computer. A "data transfer standard" assumes the data are being transferred from one computer to another.

DBMS - see Database Management System

Degradation - The process by which a chemical is reduced to a less complex form (Government Institutes, 1990).

Designated Uses - are those uses specified in water quality standards for each water body or segment whether or not they are being attained (USEPA, 1994).

Desorption - the opposite of sorption, or the release of a substance by a material to which it was formerly bound. In this report, refers to the release of contaminants from soil or sediment particles.

Dewatering - the removal of water by such processes as filtration, centrifugation, pressing, and coagulation to prepare sewage sludge for disposal by burning or landfill (Government Institutes, 1990).

Discharge - Includes, but is not limited to, any spilling, leaking, pumping, pouring, emitting, emptying or dumping of a substance (Government Institutes, 1990).

Discharge Monitoring Report - The EPA uniform national form, including any subsequent additions, revisions, or modifications, for the reporting of self monitoring results by NPDES permitees (Government Institutes, 1990).

Dose - The quantity of a chemical to which an organism is exposed (Government Institutes, 1990).

E

Ecological Impact - The effect that a man-made or natural activity has on living organisms and their non-living environment (Government Institutes, 1990).

Ecology - The relationship of living things to one another and their environment, or the study of such relationships (Government Institutes, 1990).

Ecosystem - system consisting of a biotic community and its abiotic environment (*Pratt*, 1995).

Effluent – Wastewater, treated or untreated, that flows out of a treatment plant, sewer, or industrial outfall. Generally refers to wastes discharged into surface waters (Government Institutes, 1990).

Effluent limitation - Any restriction established by a State or the Administrator on quantities, rates, and concentrations of chemical, physical, biological, and other constituents which are discharged from point sources into navigable waters, the waters of the contiguous zone, or the ocean, including schedules of compliance (Government Institutes, 1990).

Environmental fate - The destiny of a chemical after release to the environment; involves considerations such as transport through air, soil and water, bioconcentration, degradation etc. (Government Institutes, 1990).

Estuary - (1) protected and partially enclosed bay area where fresh and salt water meet and mix. (*Pratt*, 1995) (2) Region of interaction between rivers and nearshore ocean waters, where tidal action and river flow create a mixing of fresh and salt water. These areas may include bays, mouths of rivers, salt marshes, and lagoons. These brackish water ecosystems shelter and feed marine life, birds and other wildlife (Government Institutes, 1990).

F

Feasibility study - A process undertaken by the lead agency (or responsible party if they will be developing a cleanup proposal) for developing, evaluating, and selecting remedial actions which emphasizes data analysis. The Feasibility study is generally performed concurrently and in an interdependent fashion with the remedial investigation (Government Institutes, 1990).

Floc - A clump of solids formed in wastewater by biological or chemical action (Government Institutes, 1990).

Flocculation - Separation of suspended solids during waste water treatment by chemical creation of clumps of flocs (Government Institutes, 1990).

Flow through - refers to the continuous or very frequent passage of fresh test solution through a test chamber with no recycling (Government Institutes, 1990).

Food Chain - linear sequence of organisms, each feeding upon the lower trophic level (*Pratt*, 1995).

G, H

General permit - (1) an NPDES "permit" issued under [40CFR] authorizing a category of discharges under the Clean Water Act within a geographical area. (2) A permit applicable to a class or category of dischargers (Government Institutes, 1990).

Gravity separation - The separation of mixed material immersed in a liquid according to the differential specific gravities of its components (Government Institutes, 1990).

Graywater - Gally, bath, and shower water (Government Institutes, 1990).

Ground Water - Water in a saturated zone or stratum beneath the surface of land or water (Government Institutes, 1990).

Habitat - The sum of environmental conditions in a specific place that is occupied by an organism, population, or community (Government Institutes, 1990).

Heavy metals - Metallic elements like mercury, chromium, cadmium arsenic and lead, with high molecular weights. They can damage living things at low concentrations and tend to accumulate in the food chain (Government Institutes, 1990).

Hydrocarbon - Any of a vast family of compounds containing carbon and hydrogen in various combinations: found especially in fossil fuels (Government Institutes, 1990).

Hydrogeology - The geology of ground water, with particular emphasis on the chemistry and movement of water (Government Institutes, 1990).

Hydrology - the science dealing with the properties, distribution, and circulation of water (Government Institutes, 1990).

Hypertext - A term coined by Ted Nelson around 1965 for a collection of documents (or "nodes") containing cross-references or "links" which, with the aid of an interactive browser program, allow the reader to move easily from one document to another. This concept has now been extended to "hypermedia" that include not just text but also graphics, sound, video and other kinds of data. See URL: http://wombat.doc.ic.ac.uk/

Hypertext Transfer Protocol (HTTP) - The client-server TCP/IP protocol used on the World-Wide Web for the exchange of HTML documents. See URL: http://wombat.doc.ic.ac.uk/

Hypertext Mark-up Language (HTML) - Hypertext document format used by the World-Wide Web. HTML is a subset of the Standard Generalized Markup Language (SGML). See URL: http://wombat.doc.ic.ac.uk/

I, J, K

Implementation - putting a plan into practice by carrying out planned activities, including compliance and enforcement activities, or ensuring such activities are carried out (Government Institutes, 1990).

Indicator - an event, entity, or condition that typically characterizes a prescribed environment or situation; indicators determine or aid in determining whether or not certain stated circumstances exist or criteria are satisfied (Government Institutes, 1990).

Inorganic Chemicals - chemical substances of mineral origin, not of basically carbon structure (Government Institutes, 1990).

Internet - The Internet is the largest internet (i.e., network of networks) in the world. It is a three level hierarchy composed of backbone networks (e.g., ARPAnet, NSFNet, MILNET), mid-level networks, and stub networks. These include commercial (.com or .co), university (.ac or .edu) and other research networks (.org, .net) and military (.mil) networks and span many different physical networks around the world with various protocols including the Internet Protocol. See URL: http://wombat.doc.ic.ac.uk/

International Organization for Standardization (ISO) - A voluntary, non-treaty organization founded in 1946, responsible for creating international standards in many areas. Its members are the national standards organizations of 89 countries, including the American National Standards Institute. See URL: http://www.iso.ch/infoe/intro.html

Intrusion water - water originating from ground or surface waters that enters the dry-docks either by flaws in structural integrity (i.e., through seams and cracks in the walls), or by design (i.e., to "relieve" the walls and floors from excessive external water pressures).

L, M, N, O

Leach - to undergo the process by which materials in the soil are moved into a lower layer of soil or are dissolved and carried through soil by water (Government Institutes, 1990).

Leaching - dissolving and removing of nutrients by water out of soil, litter, and organic matter (*Pratt*, 1995).

Lethal Dose - LD_{50} generally, the quantity of a substance which is fatal to 50 percent of the population on which it is tested. With large test subjects it is often given as a quantity per unit of body weight (Government Institutes, 1990).

Local Area Network (LAN) - A data communications network which is geographically limited (typically to a 1 km radius) allowing easy interconnection of terminals, microprocessors and computers within adjacent buildings. Ethernet and FDDI are examples of standard LANs. See URL: http://wombat.doc.ic.ac.uk/

Metadata - Higher level information that describes the content, quality, structure, and accessibility of a specific data set (Michener et al., 1995). A variety of metadata standards exist or are under development for environmental data.

Method Detection Limit (MDL) - The minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte (USEPA, 1990c).

Mixing Zone - is an area where an effluent discharge undergoes initial dilution and is extended to cover the secondary mixing in the ambient water body. A mixing zone is allocated impact zone where water quality criteria can be exceeded as long as acutely toxic conditions are prevented (USEPA, 1994).

Modeling - an investigation technique using a mathematical or physical representation of a system or theory that accounts for all or some of its know properties. Models are often used to test the effect of changes of system components on the overall performance of the system (Government Institutes, 1990).

Monitoring - periodic or continuous surveillance or testing to determine the level of compliance with statutory requirements and/or pollutant levels in various media or in humans, animals, and other living things (see also sampling) (Government Institutes, 1990).

National Pollutant Discharge Elimination System - NPDES the national program for issuing, modifying, revoking and reissuing, terminating, monitoring and enforcing permits, and imposing and enforcing pretreatment requirements, under sections 307, 402, 318, and 405 of the Clean Water Act. The term includes an approved program (Government Institutes, 1990).

Natural Resources - land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other such resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by the United States (including the resources of fishery conservation zones established by the Magnuson Fishery Conservation and Management Act), any State or local government, or any foreign government (as defined by section 101(16) of CERCLA) (Government Institutes, 1990).

Non-point Source - causes of water pollution that are not associated with point sources, such as agricultural fertilizer runoff, sediment from construction (Government Institutes, 1990).

Optical Character Recognition (OCR) - Recognition of printed or written characters by computer. (URL: http://wombat.doc.ic.ac.uk/). As commonly used, OCR software reads a graphic image file, such as a bit map, generated by an optical scanner and attempts to recognize the characters (i.e., letters, numbers, symbols, etc.) from the pattern of "on" and "off" bits in the image. The software then translates the recognized character into an equivalent computer code, such as ASCII.

Organotins - chemical compounds used in anti-foulant paints to protect the hulls of boats and ships, buoys, and dock pilings from marine organisms such as barnacles (Government Institutes, 1990).

Outfall - the place where an effluent is discharged into receiving waters (Government Institutes, 1990).

P, Q, R

Permit - an authorization, license, or equivalent control document issued by EPA or an approved state agency to implement the requirements of an environmental regulation; e.g., a permit to operate a wastewater treatment plant or to operate a facility that may generate harmful emission (Government Institutes, 1990).

Photodegradation - the breakdown of materials or chemicals by light.

Plume - a visible or measurable discharge of a contaminant from a given point or origin. Can be visible or thermal in water (Government Institutes, 1990).

Point Source - a stationary location where pollutants are discharged, usually from an industry; a point source is any discernable, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, vessel, or other floating craft, from which pollutants are or may be discharged (Government Institutes, 1990).

Pollutant - generally, any substance introduced into the environment that adversely affects the usefulness of a resource (EPA Glossary of Environmental Terms). In this report, pollutant is used interchangeably with contaminant to provide better readability.

Population - group of organisms of the same species living in the same area (*Pratt*, 1995).

Pretreatment - the reduction of the amount of pollutants, the elimination of pollutants, or the alteration of the nature of pollutant properties in wastewater to a less harmful state prior to or in lieu of discharging or otherwise introducing such pollutants into a POTW. The reduction or alteration can be obtained by physical, chemical or biological processes, process changes or by other means (Government Institutes, 1990).

Pretreatment Requirements - any substantive or procedural requirement related to pretreatment imposed on an industrial user (Government Institutes, 1990).

Process Water - in this report, refers to any water that is known to contain, or has come in contact with, pollutants or toxic materials resulting from industrial operations in a shipyard dry-dock..

RDBMS - see Relational Database Management System

Relational Database Management System (RDBMS) - A class of database management systems that represent data in the form of tables or relations (McFadden and Hoffer, 1994).

Release - any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment (Government Institutes, 1990).

Remedial Investigation - a process undertaken by the lead agency (or responsible party if the responsible party will be developing a cleanup proposal) which emphasizes data collection and site characterization. The remedial investigation is generally performed concurrently and in an interdependent fashion with the feasibility study (Government Institutes, 1990).

Resuspension - the return of sediments lying on the bottom of a water body into the water column. Can be caused by a variety of human or natural causes, including dredging, strong bottom currents, and bioturbation.

Richness - component of species diversity that considers the total number of species present in an area (*Pratt*, 1995).

Risk Assessment - a qualitative or quantitative evaluation of the environmental and /or health risk resulting from exposure to a chemical or physical agent (pollutant); combines exposure assessment results with toxicity assessment results to estimate risk (Government Institutes, 1990).

Runoff - that portion of precipitation that flows over the ground surface and returns to streams. It can collect pollutants from air and land and carry them to the receiving waters (Government Institutes, 1990).

S

Sampling - used in this report to refer to the process of collecting a representative portion of a specific medium (i.e. water, sediment, or soil) or biological community for the purpose of analyzing its chemical constituents or other characteristics in a laboratory. When sampling occurs repeatedly at a particular location or for a particular biological community, it is called monitoring (see that definition).

Sediments - in this report, refers to the soil, sand, and minerals that lie on the bottom of a body of water.

Seepage - the movement of liquids or gases through soil without the formation of definite channels (Government Institutes, 1990).

Sheen - an iridescent appearance on the surface of water; a quantity of oil that creates a sheen is a harmful quantity subject to regulation under section 311 of the Clean Water Act (Government Institutes, 1990).

SIC - the Standard Industrial Classification Manual, published by the Office of Management and Budget in the Executive Office of the President, defines industries in accordance with the composition and structure of the economy and covers the entire field of economic activities. The Calendar of Federal Regulations uses SIC terminology whenever possible throughout the "Sectors Affected" sections (Government Institutes, 1990).

Significant Discharge - any point source discharge for which timely management action must be taken in order to meet the water quality objectives within the period of the operative water quality management plan. The significant nature of the discharge is to be determined by the State, but must include any discharge which is causing or will cause water quality problems (Government Institutes, 1990).

Sorption - in this report, the process by which contaminants are attracted to and bound to other materials, such as to soil or sediment particles.

Source - any building, structure, facility, or installation from which there is or may be the discharge of pollutants (Government Institutes, 1990).

Species Abundance - commonness or number of species and the number of individuals in each species found in a community (*Pratt*, 1995)

Spill - any unplanned discharge or release of hazardous waste onto or into the land, air, or water. (2) The accidental spilling, leaking, pumping, emitting, emptying, or dumping of hazardous wastes or materials which, when spilled, become hazardous wastes into or on any land or water (Government Institutes, 1990).

Standard Operating Procedure - a document which describes in detail an operation, analysis, or action which is commonly accepted as the preferred method for performing certain routine or repetitive tasks (Government Institutes, 1990).

Steady-State Model - is a fate and transport model that uses constant values of input variables to predict constant values of receiving water quality concentrations (USEPA, 1994).

Storm Sewer - a sewer designed to carry only storm waters, surface runoff, street wash waters, and drainage (Government Institutes, 1990).

Storm Water Runoff - water discharged as a result of rain, snow, or other precipitation (Government Institutes, 1990).

Surface Water - water that flows exclusively across the surface of the land from the point of application to the point of discharge (Government Institutes, 1990).

T, U, V

Teratogenic - substances that are suspected of causing malformations or serious deviations from the normal type, which can not be inherited in or on animal embryos or fetuses (Government Institutes, 1990).

Tidal - a situation in which the water level periodically fluctuates due to the action of lunar (moon) and solar (sun) forces upon the rotating earth (Government Institutes, 1990).

Total Maximum Daily Load (TMDL) - is the sum of the individual waste load allocations (WLAs) and load allocations (LAs); a margin of safety is included with the two types of allocations so that any additional loading, regardless of source, would not produce a violation of water quality standards (USEPA, 1994).

Total Suspended Solids (TSS) - a measure of the suspended solids in wastewater, effluent, or water bodies, determined by using tests for "total suspended non-filterable solids" (Government Institutes, 1990).

Toxic - a chemical falling within any of the following categories: (a) a chemical with a median lethal dose (LD_{50}) or more than 50 milligrams per kilogram but not more than 500 milligrams per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each. (b) A chemical that has a median lethal dose (LD_{50}) or more than 200 milligrams per kilogram but not more than 1,000 milligrams per kilogram of body weight when administered by continuous

contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each. (c) A chemical that has a median lethal concentration (LC_{50}) in air of 200 parts per million by volume or less of gas or vapor, or 2 milligrams per liter or less of mist, fume, or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 200 and 300 grams each (Government Institutes, 1990).

Toxic Pollutant - refers to those pollutants, or combination of pollutants, including disease-causing agents, which after discharge and upon exposure, ingestion, inhalation, or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains, will, or on the basis of information available to the administrator, cause death, disease, behavioral abnormalities, cancer, genetic mutations, physical malfunctions, in such organisms or their offspring (USEPA, 1994).

Toxicity - (1) the property of a substance to cause any adverse physiological effects. (2) The quality or degree of being poisonous or harmful to plant, animal or human life (Government Institutes, 1990).

Toxicity Test - is a procedure to determine the toxicity of a chemical or a effluent using living organisms. A toxicity test measures the degree of effect on exposed test organisms of a specific chemical or effluent (USEPA, 1994).

Trophic Level - classification of organisms in an ecosystem according to feeding relationships; position within a food chain (*Pratt,* 1995).

Underground Storage Tank (UST) - any one or combination of tanks (including underground pipes connected thereto) which is used to contain an accumulation of regulated substances, and the volume of which (including the volume of the underground pipes connected thereto) is 10 percent or more beneath the surface of the ground (Government Institutes, 1990).

Uniform Resource Locator (URL) - A draft standard for specifying an object on the Internet, such as a file or news group. URLs are used extensively on the World-Wide Web. They are used in HTML documents to specify the target of a hyperlink. see URL: http://wombat.doc.ic.ac.uk/

W, X, Y, Z

Waste Load Allocation (WLA) - is the portion of a receiving water's TMDL that is allocated to one of its existing or future point sources of pollution (USEPA, 1994).

Waste Oil - used products primarily derived from petroleum, which include, but are not limited to, fuel oils, motor oils, gear oils, cutting oils, transmission fluids, hydraulic fluids, and dielectric fluids (Government Institutes, 1990).

Water Quality Assessment - is an evaluation of the condition of a water body using biological surveys, chemical-specific analyses of pollutants in water bodies, and toxicity tests (USEPA, 1994).

Water Quality Limited Segment - refers to any segment where it is known that water quality does not meet applicable water quality standards and /or is not expected to meet applicable water quality standards even after application of technology-based effluent limitations required by sections 301 (b)(1)(A) and (B) and 306 of the Act (40 CFR 131.3.) (USEPA, 1994).

Weathering - mechanical and chemical breakdown or decomposition of rock material that leads to the formation of soil. (*Pratt*, 1995)

Whole-Effluent Toxicity - is the total effect of an effluent measured directly with a toxicity test. (USEPA, 1994)

Wide Area Network (WAN) - A network, usually constructed with serial lines, extending over distances greater than one kilometer. See URL: http://wombat.doc.ic.ac.uk/

World-Wide Web (WWW) - An Internet client-server hypertext distributed information retrieval system which originated from the CERN High-Energy Physics laboratories in Geneva, Switzerland. On the WWW everything (documents, menus, indices) is represented to the user as a hypertext object in HTML format. Hypertext links refer to other documents by their Uniform RLs. These can refer to local or remote resources accessible via various Internet protocols, including files transfers (FTP), menus (Gopher), virtual terminal (Telnet) or news, as well as those available via the HTTP protocol used to transfer hypertext documents. The client program (known as a browser), such as Mosaic© or Netscape©, runs on the user's computer and provides two basic navigation operations: to follow a link or to send a query to a server. A variety of client and server software is freely available. See URL: http://wombat.doc.ic.ac.uk/

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14. ABSTRACT
This report focuses on visits by the Marine Environmental Support Office (MESO) staff to the five naval shipyards not slated for closure when the project began (Long Beach, Portsmouth, Puget Sound, Norfolk, and Pearl Harbor). The analysis contained in this report is based on questionnaires sent to the shipyards, in-person and telephone interviews with shipyard personnel, research of related environmental documents, information already on file at MESO, and site visits to the shipyards to view the processes, discharges, and other activities affecting the receiving waters. MESO found there is a general lack of planning at the shipyards for changes that will almost certainly result from current regulatory trends. There is little effort to share data and insights across programs or to work toward the integrated, risk- approach proposed by EPA. These findings were expected, and they reinforce the NAVSEA decision to bring MESO and the shipyards into a partnership to plan an integrated long-term marine environmental compliance program.

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